VLBI Software Documentation
Scheduling Program

sked: Interactive/Automatic Scheduling Program

N. R. Vandenberg
NVI, Inc.

Program Reference Manual

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The following typographical and font conventions are used throughout this document.

Times New Roman	Standard font for the normal text of this manual.
Times italics	Used for emphasis in normal text. Also used for subsection titles that appear in-line at the start of a paragraph.
`Courier`	File names, directories, and computer names.
`Courier`	Indicates what the computer types. Command responses appear in this font, also listings of files.
`Courier bold`	Indicates what the user types verbatim. Command names and sample commands are in this font.
Arial italics	Indicates a variable, context-dependent quantity, i.e. the parameters to a command or the contents of an output line.

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1.0 Purpose and General Overview

1.1 What is sked?

`sked` is an interactive program that helps you prepare schedules for VLBI observing sessions. You can

- enter an entire schedule interactively,
- automatically have `sked` select scans for you,
- edit an existing schedule regardless of how it was generated, or
- list, check, evaluate and summarize any schedule.

`sked` is the first program you would run in preparation for a VLBI experiment. `sked` also offers a convenient way to incorporate catalog information on sources, stations, and observing modes into your schedule.

As its output, `sked` writes a "schedule file" which is simply an ASCII file with different labeled sections. This file contains all the information needed to acquire VLBI data at all network stations and then process it at a VLBI correlator. The file format is described in detail in the **Schedule File Format** manual. The convention is to name these files with a `.skd` extension. It is anticipated that the next release of `sked` will be able to write a file in VEX format.

As input, `sked` reads the ASCII "schedule file". The following types of schedule files can be read into `sked`:

- a `.skd` file written by `sked`,
- a `.drg` file written by `PC-SCHED`, or
- a `.skd` file written in VEX format by NRAO's `sched`.

When you are running interactively, `sked` can display a list of all the sources that are visible at each station at the given time. This aids in selecting the next observation. You can make plots of the distribution of scans made so far, plot the distribution of sources on the sky, and display source visibilities at a station during the day.

`sked` can be set up so that it automatically selects scans based on optimization criteria that you specify. The major criteria for optimization are covariance and sky coverage. Among the minor criteria, you can maximize the number of observations and minimize the time between scans. The automatic scheduling feature was originally developed by Heinz Steufmehl of the University of Bonn, Geodetic Institute.

When you attempt to schedule a new scan, `sked` makes sure the source is visible at all the stations which are to participate in the scan and that the scan can be completed at all stations. Calculations of telescope pointing position and slewing time are computed appropriately, taking into account motion of the source during the slew. Source flux densities and antenna sensitivities can be used, along with user-specified minimum SNRs, to compute scan times for each station automatically. Tape usage is calculated, and sufficient time is allowed for changing tapes and rewinding. Whether you use automatic scan selection or manual scheduling, all of these features of `sked` are fully used.

After you generate your schedule, the `.skd` file is copied to a central server location where the participating stations can access it electronically. The stations download the file and then run the Field System program `drudg` to make control files and listings for the experiment.

1.2 Definitions

Note the definition of these terms:

scan: A scan is the time period during which a network of stations observes the same source simultaneously; possibly each station observes for a different length of time. A scan constitutes one line in the `$SKED` section of the schedule file. When you run sked interactively, you are scheduling one scan each time you specify a source and network of stations to be scheduled. A scan begins at the same time at all stations participating in the scan.

subnet: A subnet is a subset of the full network of stations that are participating in an experiment session. The term “subnetting” usually refers to geodetic schedules that makes use of many varying subsets of stations, frequently with subnets observing simultaneously.

observation: An observation is a single-baseline recording that would produce one delay point in a data base for analysis. There may be, and usually are, multiple observations for each scan. For example, a 3-station scan produces 3 observations, a 4-station scan produces 6 observations.

subconfiguration: A subconfiguration is a group of scans that could be scheduled at approximately the same time. Each of the scans in a subconfiguration is on a different source and with a different subnet. During automatic scan selection sked considers many possible subconfigurations of the full network as it decides which subconfiguration should be selected. For example, with a 6-station network, some of the possible subconfigurations include 1) all 6 stations observing the same source (1 scan, 15 observations), 2) 5 stations observing the same source (1 scan, 10 observations), 3) 4 stations observing one source, 2 stations observing another source (2 scans, 7 observations), 4) 2 stations observing one source, 2 stations another, and 2 stations a third (3 scans, 3 observations). Each of these possibilities, for each mutually visible source or sources, constitutes a possible subconfiguration. For a 6-station network with moderate baseline lengths and a few dozen sources there are usually hundreds of subconfigurations.

1.3 Distribution and Support

The files necessary to install the HPUX/7000 version of `sked` are available via anonymous `ftp` to `gemini.gsfc.nasa.gov`. Instructions for getting the files and installing the program are found in Section 5 of this manual.

Only the HPUX/9000-700 version of the program is supported now. Older versions of `sked` that run on 300- and 800-series machines are not supported but they could still be used and will generate compatible files that can be read by current versions of `sked` and `drudg`.

Questions, problems, and comments may be addressed at any time to N. Vandenberg by sending e-mail to `nrv@gemini.gsfc.nasa.gov`.

1.4 Compatibility with Earlier Schedule File Formats

There have been few changes in the format of the schedule file over the lifetime of `sked`. The program remains backwards compatible, that is, it can read and understand any of the old types of schedules. Some parameter names have changed but the basic information about sources, stations, observing modes, and scans should be read correctly into `sked`.

The schedule file format remains compatible with the requirements of the Mark IIIA correlator. Extensions to the schedule file were made so as to introduce new sections or new lines that do not affect the correlator software.

2.0 User Guide

2.1 Running sked Interactively

2.1.1 Getting Started

The `sked` program should be installed in a directory that is in your search path, so you need only type:

```
prompt> sked
```

If you already have a schedule file and are going to edit it you can specify the file name on the command line, as in this example:

```
prompt> sked ca036
```

If you do not give any extension (i.e. no period in the file name) then `sked` will assume an extension of `.skd` for the file. In the above example, `sked` looks for a file named `ca036.skd` in the local directory from which you are running.

If you did not type a file name on the command line, `sked` will prompt you for the name of a schedule file to be edited:

```
Schedule file name (blank if none, :: to quit):
```

If you are starting a new schedule, simply press `Enter`. Otherwise, type the name of the file that holds the schedule. If you do not type a file extension, `sked` will assume the extension is `.skd`.

Any path name specified in a control file (see page SKED-11) will be prepended to the file name you type, unless you type an absolute path name in response to the prompt. An absolute path name is recognized if you start the file name with the `/` character. If you run under `/users/xxx` and you want to access a schedule in `cct`'s area you would type:

```
... if none, :: to quit): /users/cct/ca036.skd
```
or
```
... if none, :: to quit): ../cct/ca036.skd
```

If you don't have permission to write in the `cct` area, the schedule will be read-only and you won't be able overwrite it. You can, however, save it into an area where you do have permission to write.

If the schedule file has some observations in it, the starting date is picked up from the first observation. If there is no schedule file or if there are no observations in it, then you are prompted for a starting date and time:

```
Starting date/time in form yydddhhmmss or yymmddhhmmss
```

Enter the date and time using either date format (day of year or month and day). You will be re-prompted if necessary until a valid date and time is entered. Examples:

```
Starting ... yydddhhmmss or yymmddhhmmss  960321160000
```

is equivalent to

```
Starting ... yydddhhmmss or yymmddhhmmss  96080160000
```

If you want to quit at this point, type `::` instead:

```
Starting ... yydddhhmmss or yymmddhhmmss  ::
```

and `sked` will finish.

2.1.2 On-line Help

You can get help information by typing the command

```
? ?
```

A full page of all commands is displayed. You can also get a reminder of the syntax of any command by typing the help command followed by the command you want help on. For example,

```
? ? snr
```

would display the syntax for the **snr** command. At the end of this section starting on page SKED-16 there are lists of the current sked help display and the full command syntax display and other syntax information.

2.1.3 Selecting Sources, Stations, Frequencies

The commands to select sources, stations, and frequency codes from catalogs must be issued interactively because cursor movements are used to indicate which items you want to select from the catalogs.

Start the selection with the command **sources select**. A display will appear at the top of the screen with the names of all the sources in the sked catalog. To select a source to be included in your schedule, position the cursor over one of the letters in the source name and press any key. The source name will be highlighted, indicating it has been selected. A source may be de-selected by positioning the cursor on the source name and pressing any key. The name will then return to normal.

> *CAUTION: You must use the h-j-k-l keys to move the cursor and NOT the arrow keys.*

When you have finished selecting sources, move the cursor to END SELECTION and press any key. You will then see the following:

```
SE - select entries for SKED
LI - list selected entries so far
AB - abort selection and return to SKED
OR - return with information from original SKED file
:: - return to SKED
```

Type the two letters of the option you want at the > prompt. When you type ::, sked reads the source catalog and copies the entries for the sources you have selected into a scratch file. The source names and positions are also retained in the program to be used for scheduling.

The commands to select stations and frequency codes are the same as for sources. Refer to the discussion starting on page SKED-104 for details on which catalogs are read for which commands.

2.1.4 Scheduling Observations

Observations (or, more properly, scans) are scheduled by typing the source name or number with optional parameters that specify more details about how you want the scan to be observed. Refer to the description of the **/** (new scan) command.

2.1.5 Ending a Session

There are five commands available when you have completed your schedule or when you want to end and save what you have done. Examples:

? **ec test.skd**	(exit, create a new file named "test.skd")
? **er**	(exit, replace the current file)
? **wc xx.skd**	(write, creating a new file named `xx.skd`, and continue in `sked`)
? **wr**	(write, replacing previous version, and continue in `sked`)
? **ab**	(abort, do not save any changes)

Both of the commands that replace files ask for confirmation that you want to overwrite the file. If the file does not exist, an error message is printed.

You can always exit from `sked` by aborting, in which case any changes you have made will have no effect, unless you have issued a **wr** command during your session. If you have made any changes, you will be prompted to confirm that you want to abandon them:

```
Changes have been made. Are you sure you want to abort? (Y/N)
```

If you respond with **n**, then you are returned to `sked`. If you respond with **y** then the program re-initializes and prompts for a new schedule file.

2.2 Automatic Scheduling

`sked` will select observations automatically depending on how certain switches, parameters, and commands are set up in the program. There are two types of optimization: 1) optimize to obtain uniform sky coverage, or 2) optimize the determination of certain parameters based on covariance analysis. The sky coverage switch overrides any specified parameters, i.e. when sky coverage is turned on then no optimization by covariance is done even if some parameters are turned on. Refer to the discussion of algorithms used in automatic scheduling starting on page SKED-115.

The sequence of commands to begin automatic scheduling are discussed in this section. The main commands that control automatic scheduling are the **op** and **whatsup** commands; refer to their descriptions in section 3.0 for more discussion and examples.

2.2.1 Interactive setup

The first step is to interactively set up the sources, stations, frequency codes, and parameters for the schedule. Use the **select** option with the **sources**, **stations**, **frequencies**, and **flux** commands to gather this information from sked's catalogs. For more details, refer to the descriptions of these commands, to the previous section on interactive selection (starting on page SKED-4, and the catalog access logic discussion starting on page SKED-104.

Next examine the values of sked's parameters with the **parameter** command, and change any that are desired to be different from the default. Refer to the discussion of the **parameter** command for descriptions of each parameter. The parameters are defaulted to the most common values used in typical geodetic schedules.

2.2.2 Set up optimization

Next set up the optimization criteria and parameters with the command **op set**. With this command you specify whether you want to optimize for good sky coverage or for covariance improvement. Refer to the **op** command description for information on what each switch means. When you have finished setting switches, return to the program.

2.2.3 Select first scan(s)

The optimization process requires at least one scan to begin working from. Use the **whatsup** command to display the available sources at the experiment's starting time and select an initial source to observe. Select enough scans so that all of the stations have at least one initial observation.

2.2.4 Set up matrix of normal equations

Use the command **op go** to generate the matrix of normal equations for the few observations in the schedule so far. The automatic scan selection process will be adding observations to the matrix. Go to the last scan in this initial schedule with the command **list *** so that any new scans will be added at the end of the schedule.

2.2.5 Automatic scan selection or display

At this point you can have sked begin to select scans automatically, or you can have sked determine the possible choices and display them for your evaluation.

To display the possible choices, simply use the command **whatsup**. Refer to the description of the command in section 3.0 for information on what the displays mean. Once the normal equations are set up, the **whatsup** command will always display the chart of highest-ranked subconfigurations. The first display of available sources can be suppressed with the command's **no** option. If you want to see all of the configurations that sked considers, turn on the subconfiguration display with **subcon on**.

To have scans scheduled automatically, use the optional *time* parameter with the **whatsup** command. For example, if your schedule starts at 16:00 UT, you could generate the first hour of the experiment with the command **wh _ no 170000**. As each scan or group of scans is scheduled they are displayed on the screen. When the time in the schedule reaches 17:00 UT the automatic scheduling stops and the program's prompt returns.

While there is insufficient information in the first few scans to invert the matrix of normal equations, sked automatically optimizes for sky coverage instead of parameters. When the matrix becomes invertible, optimization is done for parameters. As each scan is selected sked prints a message informing you of the type of optimization on which the selection was based. For a typical geodetic schedule setup, 30 minutes to one hour of schedule time will be optimized for sky coverage before optimization for parameters can start.

2.2.6 Generate a 24-hour schedule

An entire 24-hour schedule can be generated by issuing the **whatsup** command with an ending time 24 hours in the future. All output will appear on your screen and the terminal will be occupied for the duration of the process. At the end of the time, you can examine the schedule with the **list** command, summarize it with **sum**, etc.

The schedule generation process can also be done in background by using re-directed input and output, described in the next section.

2.3 Running in Batch Mode

You can run `sked` in a batch mode by directing it to take its input from an input file and to send its output to a log file. This mode is useful when you are generating an entire schedule automatically, a process that can take up to several hours. This section gives examples of file formats that you can use.

A sample command that will run sked non-interactively is the following:

```
prompt> sked < ppms1.input > ppms1.log &
```

This will direct `sked` to take its input from the file `ppms1.input` and to send its output to the file `ppms1.log`. The **&** at the end of the line tells the system to run the program in background.

The input file contains the commands you would have typed to `sked` if you ran the program interactively. A sample input file might contain the following commands that specify the schedule file and tell the program to generate a complete schedule:

`ppms1.skd`	Schedule file name, response to first prompt
`op go`	Set up normal equations
`list *`	Go to the end of the existing scans
`whatsup _ no 145160000`	Tells the program to generate scans automatically until 16:00 UT on day 145.
`ec ppms1.skd.auto`	Save the schedule and exit.

Refer to the descriptions of the individual commands (section 3.0) for the details of what these commands do, and refer to the cookbook for automatic scheduling starting on page SKED-7.

The log file will contain all of the display output generated by `sked` as it is running, i.e. what would have appeared on the screen. You can check the progress of the job by using the commands `more`, `tail`, `grep` or `less` on the log file.

2.4 Command Syntax Rules

The `sked` prompt is `?` whenever `sked` is requesting command input.

A `sked` command consists of a command name followed by sometimes optional key words and/or parameters. All commands and key words are full words which may be truncated to as many letters as necessary for uniqueness.

Either upper case or lower case is recognized for commands. All users type-ins, except for file names, are converted to upper case before any action is taken. Because UNIX is case sensitive, file names are taken exactly as they are typed.

Command names, parameters which follow them, key words, and values must be separated by spaces.

2.5 Control Files

`sked` reads two control files when it starts, the "system" control file and your "personal" control file. These files specify paths and file names for catalog files, scratch areas, and printer scripts. Both files are identical in format and have the same name, `skedf.ctl`. The system control file resides in a directory specified at installation and is read when `sked` starts. `sked` also looks for a `skedf.ctl` file in the local directory from which the program is run. If the personal control file exists, any lines in it override the corresponding lines in the system control file.

Information in the control file includes: locations of all `sked` catalogs, directory for scratch files, directory for schedule files, directory for `drudg` output files, and printer commands or scripts. A listing of the distributed system control file is on page SKED-131, and a sample personal control file is on page SKED-147. Extensive comments are included in the system control file regarding the types of entries that can be made.

You can control where your schedule files are written and where `sked` gets its catalog information by having a `sked` control file in your directory.

An example of the use of the personal control file is the following. If you want the schedules you write to go into a subdirectory named `schedules`, you (user `xxx`) would include these lines in your version of the control file:

```
$schedules
/users/xxx/schedules
```

If you wanted to use a separate source catalog with just your favorites, you could include the lines:

```
$catalogs
source /users/xxx/sources.mine
```

Personal catalog files should be used with caution because any updates to the system catalog files will not be reflected in your personal copies.

2.6 Catalogs

`sked` reads files called "catalogs" to obtain source positions, station positions, antenna parameters, frequency sequences, etc. Refer to the **`sked`'s Catalog Files** manual for information on the contents of each catalog file and the formats of entries.

The location of the system catalog files is specified in the system control file (see page SKED-131). The location of personal catalog files, if any, is specified in the personal control file, described on page SKED-147.

Catalogs are read only when you select source, station, or frequencies for your schedule using the commands **`source select`**, **`station select`**, or **`frequency select`**. When you leave `sked` and replace or create a schedule file, the selected catalog entries are written into your schedule file. Thereafter when you enter `sked` with this schedule file the selections are read from the schedule file and you need not access the catalogs again unless you want to change any selections.

Refer to page SKED-104 for a discussion of catalog access logic.

2.7 Log File

`sked` writes a log file while you are running the program. Each of the commands you type is written into the file. The `sked` log file is named `SKL`*nnnnn* (*nnnnn* is the 5-digit process id, pid, of the `sked` run) and it is located in the scratch directory named in the `sked` control file described above. The pid is an id assigned to each UNIX process by the system. `sked` uses the pid for scratch file names to ensure uniqueness. The **`parameter list`** command will display the pid for the current run. More information on scratch files is found on page SKED-129.

The log file can be used to recover from problems without having to start all over. The log file can be used with the input redirection capability of UNIX.

Before you use the log file to recover, you have to edit it so it will work properly with redirection. The cursor sensing and setting does not work when redirecting input from a file. Therefore, the sources, stations, and frequency selections have to be removed from the log file. The command sequence that

caused sked to "blow up", if this happened, should also be removed, otherwise, the same thing will happen again. The last thing is to make sure there is a valid sequence of commands at the end of the log file. If one is not present, sked will receive a command error and will not exit properly. For example, you could add an **ec** command to save the file and then a **::** command to terminate sked.

To use redirection in UNIX, type as in the following example:

```
prompt> sked < /tmp/SKL12345
```

Remember that UNIX is case sensitive, and note that the log file in /tmp starts with upper-case SKL.

2.8 Specifying a Time Range

The user indicates a particular scan by referring to the UT date and time at which the scan is scheduled. The standard specification for the date/time consists of a series of numbers representing year, day of year, hours, minutes, and seconds in the format

yydddhhmmss (no spaces)

Example: **95303192345**

The individual numbers (**yy, ddd, hh, mm** and **ss**) may be omitted from the left; for any missing numbers, the program will assume the time values for the "current scan". For example, specifying **020000** means UT 02:00 on the current day.

Many commands require that a time range be specified. Time ranges may include specific date/times as just described, or one or more special characters:

.	indicates the time of the current scan
^	indicates the first scan of the schedule
*****	indicates the end of the schedule
_	indicates the default time range, i.e. the entire schedule

A "time range" is specified by a combination of date/times:

start-stop or *start#number*

where *start* and *stop* are either a date/time or special character as described above, and *#number* indicates the number of scans requested. If only a *start* is specified, the rest of the range is assumed to be **#1** so that only one scan is retrieved.

If *start* is not specified then the current date/time is assumed. This means that a range of **#5** implies **.#5** in the complete syntax.

The default time range specification is **^-*** that is, all scans from beginning to end of the schedule. The default time range is assumed if no time range is typed for those commands which require one (except for the **delete** command). The underline character _ can be used as a place-holder for the default time range.

2.9 Specifying a Subnet of Stations

A subset of the full network of stations may be specified by listing the 2-character station IDs, optionally separated by dashes. For example:

gn-kp-oh or **gnkpoh**

Only the first character of each station ID needs to be specified if there is no ambiguity, otherwise you must use 2-letter IDs for all stations. The example above could also be typed:

g-k-o

If the IDs are not separated by dashes, then `sked` first tries to interpret the string as a series of 2-letter IDs. If this generates an error, then `sked` tries an interpretation as 1-letter IDs. The fully unambiguous specification uses 2-letter IDs and dashes.

2.10 Interface to solve

The `sked-solve` interface is implemented in a program called `sskedh`. `sskedh` loads information generated by `sked`'s **solve** command into a set of `solve` work files for use in a simulation analysis. The user then runs `solve` in interactive or batch mode to set up parameterizations and start the least squares processing.

Refer to the description of the **solve** command in Section 3.0 for a description of what the command does and how to run `sskedh`.

2.11 Observing Satellites

Observations of satellites can be scheduled by `sked` if the appropriate orbital elements are provided in the source list. When sked recognizes that a satellite is the source, it calculates the current position of the satellite on the sky and schedules it or checks it using that position. It is left to the observing antenna to track the satellite appropriately. Scheduling satellites with `sked` has not been extensively tested so users are asked to use caution and to report any apparent problems with the program or calculations.

Following are the steps to be taken to use satellites as sources in sked.

1) *Make room.* Ensure that you have enough room for the satellite sources by checking the file `include/skparm.ftni` for the number of orbiting sources, specified in `MAX_SAT`. Please note the comments in the file about changes you may have to make to `MAX_CEL` or `MAX_SOR`, depending on the number of satellites you want to schedule.

2) *Edit source catalog.* You will need to make entries in the file that you are going to use as your source catalog to include the satellite orbital elements. If you are going to observe celestial sources as well as satellites, you can copy the source catalog you normally use and add the appropriate satellite's entries to it with the editor. Satellites are identified by the key word `ORBIT` that appears as the first name on the line. These lines may be placed anywhere in the source catalog file and will be sorted by sked into celestial and satellite types after selection.

The format of satellite entries in the source catalog is described in the **sked's Catalogs** manual and in the **Standard Schedule File Format** manual.

3) *Edit flux catalog.* If you are going to have `sked` calculate scan lengths you should make an entry in the flux catalog for the satellite. Satellites are typically small, very strong sources and so a high flux density and a baseline model might be appropriate. An entry might look like:

```
Satel-1   X  B  0.0  100.0  13000.0
Satel-1   S  B  0.0  100.0  13000.0
```

Entries for satellite fluxes may be placed anywhere in the catalog since matching is done by name.

4) *Edit control file*. Edit your `skedf.ctl` control file to point to the source catalog and flux catalog files that you just edited.

5) *Run sked*. Now you can run `sked,` and when you select sources you will see the satellite names in the list of available sources. Select a satellite source just as you would any other source. You can mix satellite and celestial sources in the same schedule.

When you list sources with the command source list the celestial sources will be listed first followed by the satellites. Regardless of where the satellites appeared in the source catalog, they are always placed in `sked` at the end of the list of sources.

Schedule observations on the satellites just as you would for any other source. If you use a high flux density for the satellite (as suggested in 3 above) then you may get overflows (****) in the SNR and flux fields in some displays. This means the SNR is greater than 9999 or the flux density was greater than 99.9. Because satellites are observed infrequently the size of these fields was not changed so that the displays for celestial sources are not too spread out.

The simpleminded calculations done for the **`mutualvis`** command only find the first time the source rises and sets during the UT day at a station. If the satellite has several passes each day then the display from this command will not be complete. However, recall that the calculations done for scheduling and checking are always correct and complete.

The pre-calculations for source rising and setting times are not done for satellites, rather the exact position of the satellite is calculated whenever it is scheduled to be observed.

2.11 Reference Summary of sked Commands and Parameters

The following pages contain tables listing all of `sked`'s commands, a description of the command parameters, and the default values.

Command Elements

source	Source name or number or _ for all, minimum matching on source name
station	2-character station ID or _ for all
subnet	List of 2-character IDs, optionally separated by **-**, e.g. **gn-kp-oh**. Only the first character may be used if it is unique
range	*start*-*stop* or *start*#*number* or _ for all, *start* and *stop* may be: *dddhhmmss* (if *ddd* missing, assumed current day) **^** (first observation of schedule) **.** (current observation day-time) ***** (end of schedule)
time	dddhhmmss (if *ddd* missing, assumed to be current day)
parm	Parameter name, *e.g.* **duration**
value	Value for a parameter (integer, real, or character)
number	An integer number

Default Parameter Values

(listing generated by **par list all** command)

```
Parameter values for experiment
Current SNR parameter values:
 VSCAN Y (compute scan lengths)        MINSCAN  90sec (min. scan length)
 MODSCAN  10sec (modular unit of scan) CORSYNCH   0 (corr. tape sync time)
 MINSUBNET   0 (min. subnet size)
Current Procedure parameter values:
 PREOB  PREOB  (pre-obs. procedure)    MIDOB  MIDOB  (mid-obs. procedure)
 POSTOB POSTOB (post-obs. procedure)   PREPASS    0sec (accomm. tape pass)
 CHANGE 420sec (tape change time)       SOURCE   5sec (SOURCE command time)
 SETUP  20sec (MkIII setup procedure)   MIDTP  10sec (MIDTP procedure time)
 CALIBRATION  10sec (time before obs.) DURATION 196sec (default scan time)
 HEAD   6sec (HEAD command time)       PARITY 70sec (parity check proc.)
 TAPETM   1sec (TAPE command time)     IDLE   0sec (idle time after obs.)
Current General parameter values:
 SUBNET
 PRFLAG YYYN (required procedures)     MODULAR  10sec (start time mark)
 MINIMUM   0sec (time between obs.)     LOOKAHEAD    0min (for WHATSUP)

 SYNCHRONIZE OFF (tape synchronization)SNR AUTO (reject for low SNR)
 WIDTH  0columns (width of screen)      VIS SUB  (subnet source visibility)
 CONFIRM Y (ask before adding obs)     FREQUENCY SX (default freq. code)
 SUNDIS  15deg (min. distance from sun) Schedule file:    /tmp/SKS29925
 Process ID:  29925          sked version:  970415
```

```
Printer commands: lskvega, lskpvega
Current yyddd:    97090 (1997.25)  ( 10539 MJD, MON. 31MAR.)
Greenwich sidereal time:    4:36:15.20 (16: 0: 0 UT)
Sun's RA and DEC:    0h 40.4m     4d 20.6
```

sked Command Summary

? [*command*]	Syntax for command
/ *source* (optional parameters) **start** *time* **subnet** *subnet* **cable** *stn***c*******w**]	Insert a new scan
!	Execute a command shell
abort	Abandon all changes
add *range station*	Add station to scan
autoshift [*range* [**tape** [*station*]***** **time**]]	Shift start times, tape
back [number]	Back up in the schedule
baseline [**on** [**part**] ***** **off**]	Listings by baseline
check [*range* [**idle** *value*]]	Check scheduled scans
current	List current scan
delete *range*	Delete scan range
early [*station value* ...]	Set, list early tape start
ec or **er** [*filename*]	Exit, create or replace
elevation [*station value* ...]	Set, display el. limits
flux select [*catalog*] ***** **list**	Select, list fluxes
frequencies select ***** **list**	Select, list frequencies
init	Initialize tape footages
list [*range* [*source* [*subnet* [*ellim*]]]]	List scans
max	List maximum array sizes
modify	Edit current scan
mutualvis [*source*[*subnet*[**total*xyazel*pol**]]]	Display mutual visibility
next [*number*]	List next scan(s)
optimize [**set** ***** **list** ***** **go**]	Set, list opt. parameters

parameters [**list** [**snr** * **procedure** * **general** * **all**]] * *name value ...*	List or set parameters
previous [*number*]	List previous observations
printl or **printp** [*file* * **print**]	Print, landscape or portrait
remove *range station*	Remove station from schedule
result [**fe** * **corr** * **cov**]	Display f.e. or matrices
scan [*source value ...*]	Set, list scan lengths
sitevis [*source*[*subnet*[**line*****xyazel*****polazel**]]]	Display station visibility
snr [*subnet band value* * **margin** *band value*]	Set, display SNRs
solve [*file*]	Generate file with partials
sources select * **list** * **plot**	Select, display sources
stations select * **list**	Select, display stations
subcon [**on** * **off**]	Subconfiguration display
summary [*range* [*source* [*subnet* [**stats** * line***xyazel*****polazel*****el*****az*****baseline*****file*** **hist*** **snr** [*xmin xmax ymin ymax*]]]]]	Print or plot summary of scans
tagalong *range station* [*station*]	Add station to schedule
tape [*station value ...*]	Set, list tape motion type
timeline on * **off**	Set time line display
unit [**print*****screen****file*[**append*****overwrite**]]	Change output device
untag *range*	Remove any bad observations
vlba	Toggle full-observe mode
vscan [*source* [*subnet*]]	Display var. scan lengths
wc or **wr** [*file*]	Write, create or replace
whatsup [*subnet* [**full** * **no** * **min** [*time*]]]	Display sources “up”

xlist [**on*off*feet*azel*dur*snr*max*flux**]	Extended list options
xnew [**on*off*base*snr*sefd*flux**]	New scan extended lists

2.11 sked's Time Line

```
Antenna action:    ---- on source -->&lt;--------- Tslew ---------..... ><-- on source
----->
SKED parameter:    --DUR--->IDLE     SOURCE <------ Tproc ------> ...  CAL    DUR
IDLE
Procedure name:      MIDOB  POSTOB   SOURCE <---- see table  ---> ...  PREOB  MIDOB
POSTOB
Time line events:    8 (a1) Start scan                                        8(a2)
Start scan
Tape action:                8 Stop recording                          Stop recording
8
                                    8 Start slewing to next source    8 Must be on
source now
                                           8 Start set-up procedures
                                                                 8 Complete set-up
procedures
                                                                        8 (b) Start
tape moving
```

Tslew = time required to slew to the next source

Tproc = MIDTAPE + CHANGE + PREPASS + PARITY + spin + SETUP + HEAD

Tmax = MAX (Tslew, Tproc + MAX(EARLY-CAL,0), MINIMUM)

T(a2) = T(a1) + DUR + TAPE + IDLE + SOURCE + Tmax + CAL + TAPE

The start time for a new scan, T(a2), is determined by the equations above. The words used in the equations are the SKED parameter names found in the first column of the table. The times for each of the parameters given in the equations are actually used only when the conditions listed under the Comments column are met. For example, the time specified for CHANGE is only added in when a new tape is called for, otherwise it has a zero value in the equation.

SKED parameter	Procedure name	Comments
DUR	MIDOB	Duration of scan
IDLE	POSTOB	Post-scan calibration
TAPE	ET, TAPE	Stop tape, record footage
SOURCE	SOURCE	Set up for new source and begin slewing
MIDTAPE	MIDTP	Used when tape changes direction.
CHANGE	UNLOD, READY	Used when changing tape.

PREPASS (P3)	PREPASS	Used to prepass the tape before recording.
PARITY (P2)	CHECK2C1,2	Check parity on first scan of a pass.
spin time	FASTF,FASTR	Spin tape at high speed to new footage. Used when needed to position the tape.
SETUP (P1)	SX2C1,2	Used to set up modules before every scan.
HEAD	HEAD	Used only when the heads move to a new pass.
PRFLAG	n/a	If flags P1, P2, P3 are "Y" the corresponding procedures are used as noted. If flags are "N" the corresponding procedure is never used.
EARLY	n/a	Start tape moving before scan start, EARLY = T(a2) - T(b).
CAL	PREOB	Pre-scan calibration.
MINIMUM	n/a	Minimum time between scans.

3.0 sked's Commands

This section contains detailed descriptions of each of `sked`'s commands. Each command appears on a separate page, in alphabetical order.

The syntax for each command uses the same typographical conventions established for this entire document. In addition, the following symbols are used:

*	Means "or", *i.e.* choose one of the items on either side of the symbol.
[ ]	The item in the brackets is optional and may be omitted.

??

Syntax: **??** [*command name*]

This is the help command. Typing the command with no parameters will give a list of the commands and their descriptions. If the help command is followed by a command name, a brief reminder of the syntax of that command is displayed.

The display from the command **?** is as shown below:

```
?? <command> Info for <command>      / <source>   Insert new scan
!            Execute a command shell ABORT        Abandon all changes
ADD          Add station to scan     AUTOSHIFT    Shift start times,tape
BACK         Back up in the schedule BASELINE     Listings by baseline
CHECK        Check schedule          CURRENT      List current scan
DELETE       Delete scan             EC or ER     Exit, create or replace
EARLY        Set or list early start ELEVATION    Set or list el limits
FLUX         Select, list fluxes     FREQUENCIES  Select, list freq. code
INIT         Initialize tape data    LIST         List scans
MAX          Max parameter values    MODIFY       Modify current scan
MUTUALVIS    Display mutual vis.     NEXT         List next scan
OPTIMIZATION Set, list op parameters PARAMETERS   Set or list parameters
PREVIOUS     List previous scan      PRINTL       Print file - landscape
PRINTP       Print file - portrait   REMOVE       Remove station
RESULT       Display fe or matrices  SCAN         Set, list scan lengths
SITEVIS      Display station vis.    SNR          Set, list SNRs, margins
SOLVE        Make output for solve   SOURCES      Sel.,list,plot sources
STATIONS     Select, list stations   SUBCON       Set subconfig display
SUMMARY      Print/plot summary      TAGALONG     Add station to scans
TAPE         Set or list tape motion TIMELINE     Set time line display
UNIT         Change output device    UNTAG        Remove any bad obs.
VLBA         Toggle full-obs. mode   VSCAN        Variable scan lengths
WC or WR     Write,create or replace WHATSUP      Display sources 'up'
XLIST        Extended listings       XNEW         New scan extended list
(Commands may be abbreviated so long as they are unique)
```

Examples of the display for individual commands are:

? **? wh**

```
 WHATSUP [<subnet> [FULL|MIN|NO [<time>]]]
?? li
 LIST [<range> [<source> [<subnet> [<ellim>]]]]
 <range> is <start>-<stop> or <start>#<number>
      <start>,<stop> are yydddhhmmss or ^(top), .(current),
*(end)
? ? sou
 SOURCES SELECT | LIST | PLOT
```

/ source

Syntax: **/** *source* [**start** *time* **subnet** *subnet* **cable** *stn***c*w**
duration *value* **calibration** *value* **preob** *value*
midob *value* **idle** *value* **postob** *value* **frequency** *value*]

This is the "new scan" command. *source* may be a source name or number. Minimum matching is done on the source name. The **/** is optional if a source number is typed as the command. The key words (**start**, **subnet**, **cable**, parameter names) followed by *value* may appear in any order following the *source*. A new observation, if it is valid, will be inserted into the schedule in time order. Refer to page SKED-111 for an outline of the algorithm used to schedule a new scan.

The parameters which pertain to this scan may be specified, in which case they will override, *for this observation only*, the default values set via the **parameters**, **scan**, and **snr** commands. The parameters which may be specified for a single scan are **duration**, **calibration**, **idle**, **frequency**, **preob**, **midob**, **postob**, and **subnet**. Refer to the description of the **parameters** command for a description of these parameters.

After you type the command, sked displays current and expected footages, tape spin time, idle time, slewing, durations and (if parameter **vscan** is **y**) matrix displays of SNRs, observed flux, projected baseline lengths, and effective SEFDs. An example of the display that might appear when a new source is scheduled is shown at the end of this command description. You can suppress the matrix displays with the command **xnew**.

If the parameter **confirm** is set to **y**, user OK is requested before scheduling, otherwise the scan is scheduled without asking.

If the parameter **vscan** is set to **y**, scan lengths are calculated using SNRs, source models, and station sensitivities. Matrix displays show predicted SNRs by baseline and observed fluxes by baseline, and the projected baseline lengths. Refer to page SKED-113 for a discussion of how the observed flux is calculated. If **vscan** is **n**, scan lengths as set with the **scan** command are used. No further displays are shown.

The parameter **vis** set to **sub** indicates that it is acceptable for a subset of the stations to observe the source and then stations are dropped one by one until all remaining can see the source. If **vis** is **all**, all subnet stations must be able to see the source before the scan is acceptable.

If **dur** is specified in this command then that scan duration is used for all stations regardless of what values were set with the **scan** or **snr** commands.

If parameter **snr** is **auto**, stations that cannot detect the source because of inadequate sensitivity are automatically dropped from the scan. If parameter **snr** is **man**, user approval is requested before dropping stations.

If the specified source will rise at a station within the **lookahead** parameter time, user approval is requested before sked will delay the start of the scan until the source rises.

The cable wrap on which a certain telescope should be positioned for this scan may be forced by typing the key word **cable** followed by the station identifier and the code for the wrap (**c** or **w**, see page SKED-103) with no spaces between these two characters. If the cable wrap is not specified, the program chooses the shortest move. This feature should be used with caution because there is currently no method for getting the requested cable wrap to most antenna controllers.

The subnet of stations you want to participate in this scan may be specified with the key word **subnet,** followed by a list of station identifiers (no spaces between identifiers). This is the way to schedule a scan with fewer than the full set of stations for which the source is "up". If a subnet is not specified, the stations in the default subnet (specified with the parameter **subnet**) are scheduled for the scan.

If tape usage is synchronized (parameter **synchronize on**), then tape footage counters are automatically aligned so that each station participating in the scan records its data beginning at the same footage count. If tape usage is not being synchronized (**synchronize off**), then the next available space on the tape at each station is used. In either case, the time required to spin the tape to the proper location, if any, is taken into account. Refer to page SKED-102 for a discussion of the implementation of subnetting.

The start time can be explicitly specified with **start**; refer to page SKED-13 for the format of the time specification. If a start time is specified, *no checks are made* to ensure that adequate time is allowed for tape spin and slewing, although the usual checks for the source being up and adequate SNR are made. If the start time is not specified, the program will automatically compute a start time

using the required slewing time, any necessary tape spin or change time, and the default time parameter **`modular`**. Refer to page SKED-20 for the algorithm used to compute a new start time.

If the new scan cannot be made, the reason will be reported and the scan will not be scheduled by `sked`. For example, if the source is not up (i.e. not mutually visible) for the duration of the scan, it will not be scheduled. It is also an error to attempt to change observing modes in the middle of a tape pass. Refer to page SKED-103 for a discussion of "valid scan".

The following is a sample program output for scheduling a new scan on source number 4. The parameters which affect the results of this command were set as follows: **`vscan y`**, **`snr auto`**, **`vis sub`**. The **`xnew`** option was set to **`on`** so that all the matrices are displayed.

```
? 4
 Checking new observation on 0059+581 at FT KK GN WZ
NEWOB09 - Source outside limits at KOKEE
 Checking new observation on 0059+581 at FT GN WZ
                 FT         GN         WZ
Prev. end:    1F03375    1F03375    1F03375
New start:    1F03375    1F03375    1F03375
Spin/run (ft):     0ft        0ft        0ft
        (sec):     0sec       0sec       0sec
Slewing(min):    1.8        1.0         .8
Idle time:      0:00       0:16       0:16
Durations:       176        108        176
Observation start time:      18:02:09
 SNR by baseline:
          X-band                S-band
     FT  GN          FT  GN
 GN  22          GN  15
 WZ  33  43      WZ  15  24
 Observed flux by baseline:
          X-band                     S-band
       FT   GN            FT   GN
  GN  1.2            GN   .8
  WZ  1.2  1.2       WZ   .8   .8
 Projected baseline lengths (km):
        FT    GN
  GN  5873.
  WZ  5916.  6208.
SEFDs (* = adjusted for elevation):
            FT       GN       WZ
Elevation  19.4     35.3     79.2
X-band   3000.0    933.1*   750.4*
S-band   3000.0    631.7*  1116.3*
Subnet: FT-GN-WZ-
```

```
OK? (N to abandon the observation, anything else to accept)
```

!

Syntax: **!**

This command lets you escape to the csh command interpreter while `sked` sits back and waits for you to finish. You can exit from the shell and get back into `sked` by typing either **^D** or **exit**.

abort

Syntax: **abort**

This command purges the working and scratch files and prepares to exit. The original file which was being edited, if any, is left intact.

If any changes were made in the schedule, you are asked to confirm the abort command.

add

Syntax: **add** *range station*

This command allows you to add a station to a range of scans, regardless, *no error checking*. Tape footage is initialized on the first observation and automatically computed for subsequent observations in the range.

Refer to page SKED-17 for the syntax of *range* and *station*.

The **add** command is different from **tagalong** in which the new station is checked before it is added to the scan. **add** gives you more flexibility by letting you assign the new station to a specific scan or range of scans.

autoshift

Syntax: **autoshift** [*range* [**tape** [*station*]]* **time**]]

This command is identical in function to the **check** command except that it automatically shifts the start time and/or tape status of each scan as necessary to optimize the schedule. If an scan was inserted or deleted, this command can be used to adjust all the times and/or tape usage after the editing. Refer to the timeline on page SKED-20 for how sked computes the new start time.

When beginning the time and tape calculations, sked assumes that the first scan it encounters for each station is acceptable and that those following are to be edited if needed. If a non-valid scan is encountered, for example if a source ends up not being mutually visible due to the time shifting, then the autoshifting process is terminated. The user must decide what to do about these situations. See page SKED-103 for discussion of a valid scan.

Refer to page SKED-17 for a description of *range* and *station*.

If nothing is specified after the *range*, then both start times and tape usage are adjusted as necessary. If **tape** is specified, then only the tape usage is adjusted and the start times are left alone. Tape usage is adjusted for the specified station, or for all stations if none is specified. Adjusting the tapes for a subnet is not implemented.

If **time** is specified, then only the start times will be adjusted and the tape usage will remain as it was. Note that you could end up with an impossible schedule by shifting only the time or tape use: caution is advised.

If autoshifting ends because of an error, such as a source not being up at a station, the last scan listed before the message END OF AUTOCHECKING is not a valid scan. The time of this scan is the time that would be appropriate for all stations except for the one in error. sked backs up to the previous scan and lists it as the most recent valid scan.

Messages detailing the problems which may occur are typed out before the offending scan is displayed. During **check**ing, **autoshift**ing and **tag**ing the assumption is made that the previous scan which was listed has passed inspection and is problem-free. This will be true with **autoshift**

since it will adjust the start time and tape usage as required for a “correct” scan, and it will quit if it cannot handle a problem.

back

Syntax: **back** [*number*]

This command lists the single scan which occurs *number* observations before the current one. This then becomes the new current scan. Default for *number* is **1**, which will list the scan immediately preceding the current one. If the current scan is less than *number* scans from the beginning of the schedule, the first scan in the schedule is listed.

The **back** command moves you backwards through the schedule and establishes a new current scan. It is similar to the **next** command which moves you forward in the schedule.

This command can be slow in execution because sked goes back to the beginning of the schedule and then reads forward to the requested scan.

baseline

Syntax: **baseline** [**on** [**part**] ***off**]

This command controls a flag which determines which observations will appear with the **list, next, current, previous,** and **summary** commands.

If **baseline** is **off** (this is the default setting), a scan is listed if at least one of the stations specified in the listing request (or the stations in the default subnet if none are specified), is scheduled for that scan.

If **baseline** is **on,** a scan is listed only if every station in the specified subnet is scheduled to participate in that scan.

If **baseline** is **on,** with **part** specified, a scan is included only if at least two stations in the specified subnet are scheduled to participate in that scan.

If the command is issued with no argument, its value simply toggles between **on** and **off**, with an accompanying message indicating its new setting.

check

Syntax: **check** [*range* [**idle** *value*]]

Each of the scans in the time range is checked for validity. If a scan cannot be made, a message giving the reason is printed. No modifications are made to the schedule. See page SKED-103 and the description of the **autoshift** command for additional discussion. See page SKED-17 for the syntax of *range*.

With the **idle** option, sked displays the amount of time for which a station is idle between scans. The *value* parameter can be used to specify the minimum amount of idle time there must be before a message is displayed. *value* is in seconds. This option is useful for checking whether any "holes" have been left in the schedule after editing or shifting it.

Refer to page SKED-103 for a discussion of the things sked checks for a valid scan. Messages detailing the problems which may occur are typed out before the offending scan is displayed. During **check**ing, **autoshift**ing and **tag**ing the assumption is made that the previous observation which was listed has passed inspection and is problem-free. **check** does not make any changes to the schedule but, in effect, checks transitions between pairs of observations.

If the **timeline** command switch is **on** then detailed information on the start time calculations are displayed.

current

Syntax: **`current`**

This command lists the current scan. It is equivalent to the syntax **`list .`**, but is provided as a separate command for convenience.

delete

Syntax: **delete** *range*

This command will delete the specified time range of scans from the schedule. After the deletion is completed, the current scan becomes the one just before the first deleted scan. This enables the user to start inserting new scans. The **delete** command is the only one for which the *range* does not default to the entire schedule. For this command, a time range must be specified. Refer to page SKED-13 for a description of the time formats.

The first scan deleted is the one whose start time is equal to or greater than the *range* starting time. The last scan deleted is the next one found after the *range* ending time.

early

Syntax: **early** [*station value station value ...*]

With this command you set the early tape start time that you want to use at each station. The early start for a station is defaulted to 0 seconds when the station is first selected from the catalog. Thereafter, the values set with this command are remembered even if you select another station or de-select a station.

Refer to page SKED-17 for the syntax of *station*. The early start *value* is in integer seconds.

If only the command name is typed, the current early start times are displayed. Sample:

```
ID  STATION EARLY START(sec)
FD  FD-VLBA    30
GC  GILCREEK   30
LA  LA-VLBA    30
O6  ONSALA60   30
WF  WESTFORD   30
```

The early start values are written into the $PARAM section of the schedule file when the **er**, **ec**, **wr**, or **wc** command is executed and the limits are then automatically set when the same schedule file is accessed again. The values appear on lines that begin with EARLY_START.

The value of the early start for the first station in the schedule is also written into the $PARAM section of the schedule file with the key word EARLY, for compatibility with the Mark IIIA correlators. Please remember that the Mark IIIA correlators support only a single values of early start for a schedule. Implementation of individual values for early start for each station was added to sked in anticipation of the requirements of the VEX format which allows this feature.

ec, er

Syntax: **ec** *new-file-name*
er [*existing-file-name*]

This is the standard exit command. With the **ec** command (**e**xit, **c**reate), a new file is created with the name supplied, and the file being edited is left as it was. With the **er** command (**e**xit, **r**eplace), the file being edited (or the file named in this command) is replaced by the edited version just produced in this sked session.

Before exiting, sked reads through the schedule file and checks that all of the sources and stations you have scheduled are currently selected. If not, an error message is printed and you will be asked whether you wish to exit anyway, saving the schedule file as is. If possible, you should complete selections before exiting. You can always exit using **abort.**

For the **er** command, you are asked if you want to replace the file. Only a **y** or **n** is accepted as a response, *i.e.* there is no default.

The current parameter values for the quantities in the $EXPER and $PARAM sections are always written into the output file. Other sections are re-written from sked's scratch files only if a change has been made, that is, selection has been done or new scans have been added. Unchanged sections are copied in their entirety from the original file.

With both **er** and **ec**, valid access to the file is checked. The path given in the control file, if any, is pre-pended to the file name you specify in this command. Refer to page SKED-11 for a discussion of control files.

To save intermediate versions of a scheduling session without exiting from the current schedule, use the **wc** or **wr** command.

elevation

Syntax: **elevation** [*station value station value* ...]

This command allows you to set the horizon limit you want to use at each station. One value, constant for all azimuths, may be specified. The value specified with this command is separate from, and is checked in addition to, the antenna's physical limits and horizon mask. The physical antenna limits and the horizon mask are displayed with the **stations list** command.

All values for station elevations are defaulted to 5 degrees when the station is first selected from the catalog. Thereafter, the values set with this command are remembered even if you select another station or de-select a station.

Refer to page SKED-17 for the syntax of *station*. The elevation *value* is in decimal degrees.

If only the command name is typed, the current elevation limits are displayed. Sample:

```
ID  STATION  EL LIMIT(deg)
FD  FD-VLBA    3.0
AL  GILCREEK   5.0
KK  KAUAI      3.0
LA  LA-VLBA    3.0
O6  ONSALA60   5.0
WF  WESTFORD   4.5
WZ  WETTZELL   3.0
```

The elevation limit values are written into the $PARAM section of the schedule file when the **er**, **ec**, **wr**, or **wc** command is executed and the limits are then automatically set when the same schedule file is accessed again.

flux

Syntax: **flux select** [*catalog*] * **list**

This command will read source fluxes from the flux catalog with **select** or will **list** those previously selected.

If *catalog* is specified, a flux catalog is opened with the same file name as the default flux catalog (as found in the control file) plus *catalog* as extension. For example, if the standard flux catalog is named `/usr/local/catalogs/flux.cat`, but you type the command **flux sel mobile**, then a file named `/usr/local/catalogs/flux.cat.mobile` is opened.

Refer to the **sked's Catalogs** manual for the format of the flux catalog file. Refer to page SKED-104 for information about catalog access. The flux catalog contains flux densities and Gaussian models for each source. Refer to page SKED-113 for a discussion of how the observed flux is calculated.

A fragment of a sample listing is given below.

```
 #   Source   Band Type Base Flux  Base   Flux  Base   Flux
                       Flux MajAx Ratio PA  Off1 Off2
1 1  0016+731  X  M    1.5    .3   1.0    .0    .0    .0
               S  M    1.5   1.4   1.0    .0    .0    .0
2 2  0048-097  X  M    1.2    .4   1.0    .0    .0    .0
               S  M    1.0   1.2   1.0    .0    .0    .0
3 3  0059+581  X  B   .0  3.5  5300.0
               S  B   .0  2.0  5300.0
4 4  0119+041  X  M    1.5    .5   1.0    .0    .0    .0
               S  M    1.2   1.4   1.0    .0    .0    .0
```

In the above listing, a `Type` of `M` means this is a gaussian model, and `B` means a baseline-dependent step function. For most sources, the flux density (`Flux`) and source size (`MajAx`) are the primary indicators of the source's strength. On long baselines, sources that are more extended will produce less observed flux. Use the command **vscan** *source* to see what the observed flux will be on the baselines in your schedule.

Refer to the **sked's Catalogs** manual for a detailed description of the fields in this listing.

frequencies

Syntax: **`frequencies select * list`** [*subnet*]

This command allows the user to select from a catalog a frequency sequence, actually the entire observing mode. With the **`select`** option you interactively select observing modes from the modes catalog. `sked` opens the catalog as specified in the control file, and displays the mode names and associated information found there.

> *CAUTION: You must use the h-j-k-l keys to move the cursor and NOT the arrow keys.*

If two observing modes with the same 2-letter code are selected, the second character of subsequent codes is changed. For example, if a mode with code `SX` is chosen more than once, the second SX mode will become `S2`, the third `S3`, and so on. It is unusual for a single geodesy experiment to have more than one observing mode.

Station selection must be done first in order for `sked` to retrieve the correct receiver setups, IFs and LOs, track assignments, and head positions from their respective catalogs. After the mode is selected, `sked` reads from the catalog files `freq.cat`, `rx.cat`, `loif.cat`, `rec.cat`, `tracks.cat`, and `hdpos.cat`. See page SKED-104 for further discussion about catalog access. Refer to **`sked`'s Catalog** manual for descriptions of the catalog file formats.

After selection, the default frequency sequence in the **`parameters`** command is set to the first selected code.

The **`list`** option displays a summary of the observing mode. The complete list of frequencies for a subnet of stations can also be displayed. Sample listings:

```
? freq list
  Name  Code
NEOS-WB  NW
Recording mode setup for:
   FORTLEZA KOKEE    MIAMI20  NRAO20   WETTZELL
  Mode      Tot.Rate     Tot.BandW   #chan #bits  Barrel
```

```
 C         56.000 Mbits  28.000 MHz   14   1     NONE
  Chan.BW  #Subpasses  Tracks(*fan)  Tot.tracks Speed(ips)
  2.00 MHz      2         14(*0)         0       135.00
  X-band  spanned bw=   680.0 MHz       rms spanned bw=   252.6 MHz
  S-band  spanned bw=   110.0 MHz       rms spanned bw=    43.7 MHz
  Number of channels recorded per sub-pass
         X         S       Total
          8.000     6.000    14.000
```

? **freq list ft**

```
  Name  Code
NEOS-WB  NW
Recording mode setup for FORTLEZA
  Mode      Tot.Rate     Tot.BandW   #chan #bits  Barrel
 C         56.000 Mbits  28.000 MHz   14   1     NONE
  Chan.BW  #Subpasses  Tracks(*fan)  Tot.tracks Speed(ips)
  2.00 MHz      2         14(*0)         0       135.00
  X-band  spanned bw=   680.0 MHz       rms spanned bw=   252.6 MHz
  S-band  spanned bw=   110.0 MHz       rms spanned bw=    43.7 MHz
  Number of channels recorded per sub-pass
         X         S       Total
          8.000     6.000    14.000
  Chan#    Skyfreq  BBC#   LOfreq   IF   Switch
      1     8182.99   1    8080.0   1N
      2     8222.99   2    8080.0   1N
      3     8422.99   3    8080.0   1N
      4     8562.99   4    8080.0   1N
      5     8682.99   5    8580.1   3N
      6     8782.99   6    8580.1   3N
      7     8842.99   7    8580.1   3N
      8     8862.99   8    8580.1   3N
      9     2212.99   9    2020.0   2N
     10     2222.99  10    2020.0   2N
     11     2257.99  11    2020.0   2N
     12     2297.99  12    2020.0   2N
     13     2317.99  13    2020.0   2N
     14     2322.99  14    2020.0   2N
```

init

Syntax: **`init`**

This command initializes the tape variables (footage, direction, pass number) for the current scan, thus allowing it to be used as the first scan of a schedule (or of a tape). This means all footage counters are re-set to `1F00000`. This allows the deletion of an arbitrary number of scans from the beginning of a schedule without necessitating hand-editing of the tape footages for a new first scan.

list

Syntax: **`list`** [*range* [*source* [*subnet* [*value*]]]]

This is the basic schedule listing command and also the standard way to make a scan be the "current" one. The listing can be restricted to a certain time range with *range*, to scans on a single source with *source*, and/or to scans in which a *subnet* of stations participate. If *value* is specified, only observations with elevations lower than *value* will be listed.

The default for each of the specifications is to list "all". The specifications for time, source, and stations must appear in order as listed in the syntax above. The place-holder character _ (underline) can be used to specify "all" if, for example, you want to list all times for a single source. Refer to page SKED-17 for the syntax of *range*, *source*, and *subnet*. The selection of scans to be listed is additionally determined by the **`baseline`** command.

If only the time range is specified, a listing of the scans scheduled for all stations in the default subnet will be displayed on the display unit. If a subnet is specified in this command, and **`baseline`** is **`off`**, then the scans in which any of those stations participate will be listed. If **`baseline`** is **`on`**, a scan will only be listed if each of the stations in the subnet participates in the scan. If a source name or number is specified, only scans for that source will be listed.

To insert a new scan into the schedule, use the **`list`** command to establish the preceding scan as the current one by listing it.

The new scan command (**`/`** or *source*) as well as **`list`**, **`next`**, **`back`**, **`current`**, and **`previous`** produce listings of scheduled observations on the display unit, as specified with the **`unit`** command. The listing includes the items you specified with the **`xlist`** command.

A sample listing with the initial default settings, from the command **`li ^#5`**:

```
Source      Start      DURATIONS
name     yyddd-hhmmss  Gc  Hh  Ho  Ma  Wf
0528+134 97126-180000|  70           70  70|
0637-752 97126-180000|      70  70         |
0059+581 97126-180308|  70           70  70|
```

```
1044+719 97126-180522|  70         107 107|
1334-127 97126-180612|      70  70        |
End of listing.
```

The commands **`xl az du`** followed by **`li ^#5 _ gc-wf`** produces the following output with azimuth and elevation for each station followed by the scan durations. Only three scans are listed because the requested stations participated in only three of the first five scans.

```
Source      Start      AZ EL  AZ EL  DURATIONS
name     yyddd-hhmmss    Gc      Wf    Gc  Wf
0528+134 97126-180000|  79  9| 144 56|  70  70|
0059+581 97126-180308| 103 75| 314 56|  70  70|
1044+719 97126-180522|   2 46|  23 37|  70 107|
End of listing.
```

With the **`xlist snr`** followed by **`li ^#5 _ gc-wf`** the SNRs for each baseline at both X and S are displayed.

```
Source      Start     SNR by baseline for X , S
name     yyddd-hhmmss  Gc-Wf Gc-Wf
0528+134 97126-180000| 163  60|
0059+581 97126-180308|  47  16|
1044+719 97126-180522|  26  25|
End of listing.
```

Note that only three scans are listed. These are the ones of the first five scans that contain both of the specified stations.

The two commands **`xlist flux`** and **`li _ 12 gc-wf-ma`** list the observed flux on a single source for all scans.

```
Source      Start     Observed flux by baseline for X , S
name     yyddd-hhmmss  Gc-Wf Gc-Ma Wf-Ma Gc-Wf Gc-Ma Wf-Ma
0552+398 97126-181300|3.8 1.0 1.8 3.3 2.2 2.6 |
0552+398 97126-183718|3.7 1.0 2.0 3.2 2.1 2.7 |
0552+398 97126-192021|3.4 1.0 2.4 3.2 2.2 2.8 |
0552+398 97126-195630|3.2 1.1 2.8 3.1 2.2 3.0 |
0552+398 97126-203947|2.9 1.3 3.3 3.0 2.3 3.1 |
0552+398 97126-211652|2.7 1.5 3.7 3.0 2.5 3.2 |
0552+398 97126-215437|2.6 1.9 4.0 2.9 2.7 3.3 |
0552+398 97126-222745|2.5         2.9         |
0552+398 97126-230332|2.5         2.9         |
0552+398 97126-232700|2.5         2.9         |
```

```
0552+398 97127-021435|3.6         3.2         |
0552+398 97127-025648|4.0         3.3         |
0552+398 97127-033510|4.4         3.4         |
0552+398 97127-063618|    1.2         2.3     |
0552+398 97127-072500|    1.1         2.2     |
0552+398 97127-080224|    1.1         2.3     |
0552+398 97127-084743|    1.3         2.4     |
0552+398 97127-092452|    1.5         2.5     |
0552+398 97127-104952|    2.2         2.8     |
0552+398 97127-113030|    2.6         2.9     |
0552+398 97127-122251|        3.1         3.1 |
0552+398 97127-141543|3.3 2.7 1.9 3.1 2.9 2.7 |
0552+398 97127-145026|3.6 2.3 1.7 3.2 2.8 2.6 |
0552+398 97127-153248|3.8 1.9 1.5 3.3 2.6 2.5 |
End of listing.
```

The table below gives the headings as they appear in `sked` listings along with a description of the contents of the column. The table is grouped according to the **`xlist`** options. Refer to the description of the **`xlist`** command or the above examples for information on how to turn on these options.

Heading	Description
`Source name`	Source name - the common name.
`Start yyddd-hhmmss`	Start time of the observation
`Stations`	Stations participating in this observation, in the form ncnc ... where n=ID, c=cable wrap.
`HA AZ EL`	Hour angle (hours), azimuth (degrees), and elevation (degrees), computed as of the start of the observation.
`TAPE FOOTAGE COUNTERS`	The pass number, direction, and footage count for each station, listed in the same order as station identifiers.
`DURATIONS`	Duration of the observation by station.
`SNR by baseline`	Calculated SNR on each baseline.
`Observed flux`	Flux density calculated for each baseline.
`CAL (SEC)`	Time allowed for the `PREOB` calibration procedure, seconds.
`CODE`	The Mark III frequency code.
`PREOB PROC`	Name of the procedure to be executed before observation begins.

DUR (SEC)	Duration of the observation, seconds.
MIDOB PROC	Name of the procedure to be executed during the observation.
IDLE (SEC)	Time allowed for the POSTOB procedure, seconds.
POSTOB PROC	Name of the procedure to be executed after the observation, before slewing to the next source.

max

Syntax: **max**

This command will display the values of the "maximum" parameters that were set at program compile time. This will show you the maximum number of stations that can be selected, the maximum number of sources, etc. Sample display:

```
Maximum array sizes currently set in sked and drudg
 Maximum number of sources     305     (  300 celestial,     5 satellite)
 Maximum source name length    16 characters
 Maximum number of source names in catalog  1000
 Maximum number of stations     35
 Maximum number of horizon mask pairs     60
 Maximum number of station names in catalog   100
 Maximum number of observing modes     20
 Maximum number of subpasses per head position    36
 Maximum number of observing mode names in catalog    50
 Maximum number of bands (e.g. X, S)     2
 Maximum number of observations  2000
 Maximum number of parameters that can be optimized     30
 Maximum number of sources positions that can be optimized     10
 Maximum number of configurations considered for optimization   100
```

modify

Syntax:

This command allows you to modify any part of the current scan. The current scan is printed on the screen in the exact format that it appears in the output file. A prompt character **>** is typed at the left edge of the screen just under the observation line. To change any character, space over to just under the character to be changed and type in the new character. Spaces are non-destructing. To change an existing character to a space, type the character **&**.

After your modification, the scan will be displayed as changed so that you can verify its correctness before the change is made final. If an error results from anything you type in, you will be reprompted. To abort any changes you have made and return to the original observation, respond with **a** (for abort) when asked if the line is OK.

If you just press **Enter** after the first prompt, then the original observation is unchanged.

mutualvis

Syntax: **mutualvis** [*source* [*subnet* [**total*xyazel*polazel**]]]

This command computes and displays the mutual visibility for the selected source list between the stations in the default subnet. The rising and setting times and a UT time line are printed out. The display device is used. The **mutualvis** display is a subset of the **sitevis** display. Refer to page SKED-17 for the syntax of *source* and *subnet*.

The commands **mutualvis** and **sitevis** compute and display the rise and set times for the selected sources at the selected sites. The **sitevis** display lists, for each source, the rise and set times at each site, the maximum elevation of the source at each site, and the mutual rise and set time for the maximum number of sites. The **mutualvis** display is a subset of **sitevis**. For both commands, if a single source and/or a subset of stations is specified, the display is accordingly restricted.

Printed display. In a schedule file with 7 stations, the simple command **mu** produces the following display (only the first few sources are shown in this sample):

```
 Source Visibility on 93 83
   for stations  FD-VLBA GILCREEK KAUAI LA-VLBA ONSALA60 WESTFORD WETTZELL

            RISE   SET   |0     3     6     9     12    15    18    21    |
           hh:mm  hh:mm  |------|-----|-----|-----|-----|-----|-----|-----|
1 0016+731 12:17   9:24  |77777777777777777766666777777777777777777777|
2 0048-097  0: 0   0: 0  |44322          22222222233335555434444455555444|
3 0059+581 15:19   4:47  |77777777766666655555666666666777777777777777777|
4 0119+041 18: 0  18:15  |4444322222   22222222223333555555556755555555555|
5 0208-512  0: 0   0: 0  |                                            233222 |
6 0229+131 18:54  20:15  |555544432222244222222222333335555666777755555555|
7 0454-234  0: 0   0: 0  |444433333                  222222223323433334444|
8 0458-020  0: 0   0: 0  |5555555444432222     22222222223333555555554555|
9 0528+134 21:53  23:15  |555555555544432222244222222222333333555566677775|
```

In the above display, the digits in the timeline indicate at how many stations the source is visible at that time. If the **total** option were invoked, only the 7s would be displayed. The rise and set times

are the times that the source rises and sets for the entire network. In a global network such as this one, only about half of the sources are ever mutually visible to the entire network.

The calculations and display for this command can be restricted to a single source and/or a subnet of stations. If a single source is specified, the visibility for only that source is presented. If a subnet is specified, the calculations are made only for that subset of stations. If **`total`** is specified then only times when a source is visible for all stations in the subnet will be marked on the display. The place-holder character _ (underline) can be used for *source* if, for example, you want all sources and a subnet, or for *subnet* if you want the default subnet and **`total`**.

Plots. The plotting options **`xyazel`** and **`polazel`** produce a plot for each subnet station with the visibility of each source at that station. The plots show site visibility, not mutual visibility between multiple stations. The elevation and azimuth of the selected source(s) are plotted as the source(s) traverse the sky in 24 hours. The plot is rectangular (**`xyazel`**, el 0 to 90, az 0 to 360) or polar (**`polazel`**). The individual source points are identified by using the source number as the plotting character. The plots for the **`mutualvis`** and **`sitevis`** commands are identical.

next

Syntax: **next** [*number*]

This command lists the next scan(s) in the schedule. The list starts with the scan after the current one, and a total of *number* of scans are listed. The default is to list the next one scan if *number* is not specified. If the current scan is the last one in the schedule file, this command will not list any scans.

Other commands for moving around in the schedule are: **back** for moving backwards a specified number of scans in the schedule, **previous** to list previous scans, and **list** to move to an arbitrary scan.

optimize

Syntax: **`optimize set * go * list`**

This command will set parameters and options for automatic scan selection (**`set`** option), generate the matrix of normal equations (**`go`** option), or list on the screen the parameters set so far (**`list`** option). There is no default.

With the **`op set`** command you specify interactively all of the parameters and options that sked will use for automatic selection of scans. When you invoke this command you will see a display of key words and numbers. You enter values and toggle options by first moving the cursor to the key word or number. To toggle an option on or off press any key. The keyword is highlighted if it is "on" and not highlighted if "off". To enter a number, type each digit in the place you want it. When you have completed setting options, move the cursor to `End Selection` and press any key.

> *CAUTION: You must use the h-j-k-l keys to move the cursor and NOT the arrow keys.*

The first page display for a typical schedule looks like:

```
CvgONLY Last24h Max#Obs MinTime LoclCov Best 0% LtLnHt  SNRwts  AKLMEV
Add 0ps Evn#Sor LoEl 0d Expand  RiseSet MinSlew Betw20m
  Optimize          XP      YP     DUT     PSI     EPS
GILCREEK AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
KOKEE    AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
LA-VLBA  AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
NRAO20M  AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
WESTFORD AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
WETTZELL AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
  Estimate          XP      YP     DUT     PSI     EPS
GILCREEK AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
KOKEE    AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
LA-VLBA  AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
NRAO20M  AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
WESTFORD AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.
WETTZELL AtmOffs AtmRate ClkOffs ClkRat1 ClkRat2   Lon.    Lat.     Ht.

End selection
```

This display has three parts:

1) The top two lines contain options and values for automatic selection.
2) The section labelled `Optimize` shows which parameters will be optimized for each station during automatic selection.
3) The section labelled `Estimate` shows which parameters will be estimated for this schedule. Note that you cannot optimize for a parameter unless you are estimating it. Any inconsistencies between optimized and estimated parameters are checked when you issue the **`whatsup`** command to evaluate and select observations.

The top two lines on the first page have the following options:

`CvgONLY` If on, optimize for sky coverage, otherwise for covariance. This is the major optimizing criterion for automatic scan selection. All the remaining options are considered minor options. Note that if sky coverage is selected as the major criterion, then sked ignores the optimization parameters for covariance analysis, regardless of what is highlighted on the screen. You must use the command **`op go`** to set up automatic scheduling even if no covariance analysis is going to be done. If this parameter is on, then all covariance options are ignored and the schedule is generated based on sky coverage plus the minor options. See page SKED-119 for a description of the algorithm used to calculate sky coverage. Refer to page SKED-7 for more discussion about the difference between sky coverage and covariance analysis.

`LoclCov` If on, give higher weight to configurations which yield better sky coverage. See page SKED-117 for the algorithm used to evaluate this option. This minor option gives higher weight to subconfigurations that have scans with smaller distances on the sky between observations, i.e. observations that tend to fill in holes in the sky distribution. If this option is on, the sky coverage at all stations will tend to be uniform. If this option is off, sky coverage may be more clumpy.

`Max#Obs` If on, maximize the number of observations in a scan. This is a minor option; see page SKED-117 for the algorithm used to evaluate this option. This option will give higher weight to subconfigurations with larger numbers of observations. For example, a single scan with 6 stations observing the same source (15 observations) will be weighted higher than a set of two scans with 4 stations observing one source and 2 stations observing another source (total of 7 observations). Use of this option

encourages full-network scans. If this option is not enabled, then more subnetting may occur and fewer total numbers of observations will result.

`MinTime` If on, minimize the time between the end of the previous scan and the end of the new scan. This is a minor option; see page SKED-117 for the algorithm used to evaluate this option. This option gives higher weight to subconfigurations with scans that start earlier. Total schedule time (slewing and/or idle time plus scan duration) is minimized, thus emphasizing shorter scans/stronger sources. In most schedules this option should be on so that idle time is as small as possible.

`MinSlew` If on, minimize the time between the end of the previous scan and the start of the new scan. This is a minor option; see page SKED-117 for the algorithm used to evaluate this option. This option gives higher weight to subconfigurations with scans that require a minimum of slewing time and idle time.

`Best__%` Specify `nbest`, the percentage of the best subconfigurations (already ranked according to covariance analysis or sky coverage depending on the setting of `CvgOnly`) that are to be considered for the minor options. Setting the value to zero effectively disables the minor options and forces the highest-ranked subconfiguration to be selected.

`Last__hr` Specify `nwin`, the window (in hours) for covariance analysis. Only scans within the previous `nwin` hours are included in the normal equations. For example, if `nwin=3`, scans older than 3 hours are removed from the normal equations as the selection of scans proceeds to later times. If `nwin=24` all observations of a 24-hour schedule are included in the covariance analysis.

`Add__ps` Specify `noise`, the amount of noise (in picoseconds) to be added to each observation's weight. See page SKED-116 for the equations and use of this value.

`SNRwt`
`Equalwt` Type of weight for all observations. This parameter toggles between equal weights or weights based on each observation's SNR. See page SKED-116 for the equations.

`Evn#Sor` Give higher weight to sources that have fewer observations than other sources. This option has been tested for some types of networks but it is not thoroughly debugged. This option has been left in the program so that further testing and

development can continue. The best way to even out the distribution of observations over all sources is to use the `Betwnnm` option.

`Betwnnm` Minimum time between scans on the same source, in minutes. A new scan with any subnet cannot be made until this amount of time has elapsed in the schedule. This is most effective way to ensure that all sources get observed, even the weaker ones.

`Expand` Expand the available choices of configurations. Normally all network stations or all stations less one are required to participate in each configuration (i.e., each group of scans being considered). This option enables more subnetting by allowing up to two fewer than the full network of stations to participate in a configuration. This option is useful, perhaps even necessary, for global networks where more subnetting is required. If this option is not used with global networks then substandard schedules may be generated. If this option is used with smaller networks then fewer observations will result because more subnetting will occur.

`RiseSet` Give higher weight to scans with sources rising or setting within the next `lookahead` minutes.

`LoElnnd` Give higher weight to scans that have sources being observed at any station below *nn* degrees. Also, see the discussion for RiseSet.

The `Optimize` and `Estimate` sections of the first page show the parameters available in sked for optimization and estimation. If a parameter is highlighted in the `Optimize` section it will be optimized, in a covariance sense, during selection of scans. Refer to page SKED-116 for the algorithms used. If a parameter is highlighted in the `Estimate` section it will be included in the normal equations. The optimized parameters must be a subset of the estimated parameter set: you must estimate all parameters that you want to optimize, but you can estimate additional parameters that are not being optimized.

The second page display has two sets of source names, 1) the `Optimize` section and 2) the `Estimate` section. Highlight a source name to have its position optimized and/or estimated. Note that you cannot optimize a source position unless you are estimating it. A typical page looks like:

```
  Optimize
0016+731 0048-097 0119+041 0208-512 0229+131 0234+285 0420-014 0454-234
0528+134 0537-441 0552+398 0727-115 0735+178 0823+033 OJ287    4C39.25
OK290    0954+658 1034-293 1104-445 1308+326 1334-127 1424-418 1510-089
```

```
1606+106 1622-253 1633+38  1739+522 1741-038 1749+096 1803+784 1921-293
2145+067 2234+282 2255-282
  Estimate
0016+731 0048-097 0119+041 0208-512 0229+131 0234+285 0420-014 0454-234
0528+134 0537-441 0552+398 0727-115 0735+178 0823+033 OJ287    4C39.25
OK290    0954+658 1034-293 1104-445 1308+326 1334-127 1424-418 1510-089
1606+106 1622-253 1633+38  1739+522 1741-038 1749+096 1803+784 1921-293
2145+067 2234+282 2255-282

End selection
```

After you have set up the criteria on either or both pages, move the cursor to `End Selection` and hit any key. The following options are shown:

```
  PA - display station parameters for selection
  SO - display source parameters for selection
  GO - return to SKED, create new normal equations
  EN - return to SKED, do not create new normal equations
>
```

Type in the two letters indicating your choice.

You can return to `sked`, without or without generating the normal equations, go to the other parameter page or the current parameter page.

The `GO` menu option, or the command **`op go`**, results in `sked` generating the matrix of normal equations for observations already existing in the schedule. See page SKED-116 for a description of the equations.

The command **`op list`** will list on the display unit the same options and parameters that are shown on the screen page displays. This command is provided as a convenient way to document in an output listing the parameters you were optimizing. The listing leaves blanks for parameters or options that would not be highlighted on the display pages. A sample display:

```
Optimization    parameters    for    experiment    RD9304    from    schedule    file
./../schedules/rd9304.skd
        Last 3h Max#Obs MinTime         Best 5% LatLonH SNR wts
Add30s
  Optimize          XP      YP     DUT
FD-VLBA          AtmRate
GILCREEK         AtmRate
KAUAI            AtmRate
LA-VLBA          AtmRate
ONSALA60         AtmRate
```

```
WESTFORD         AtmRate
WETTZELL         AtmRate
  Estimate          XP      YP     DUT
FD-VLBA  AtmOffs AtmRate ClkOffs ClkRat1
GILCREEK AtmOffs AtmRate
KAUAI    AtmOffs AtmRate ClkOffs ClkRat1
LA-VLBA  AtmOffs AtmRate ClkOffs ClkRat1
ONSALA60 AtmOffs AtmRate ClkOffs ClkRat1
WESTFORD AtmOffs AtmRate ClkOffs ClkRat1
WETTZELL AtmOffs AtmRate ClkOffs ClkRat1
```

All of the parameter settings that are displayed on the two pages of the **op** command are saved in the $OP section of the schedule file when you save the schedule with the **ec** or **er** command. The next time you enter sked with this schedule file your options and parameters will automatically be set up just as is done for source and station selections.

When a new station is selected all of the parameters for that station are initialized to off. The same is true for new sources.

parameters

Syntax: **parameters** [[**list** [**snr** * **procedure** * **general** * **all**]] *parm value parm value* ...]

This command is used to display or set parameters used by sked for many of its operations.

The parameters which can be set with this command are displayed with the **list** option. Parameter names may be truncated so long as they remain unique. Default values for all parameters are listed on page SKED-17.

The **parameter** command with no options will give the listing of general parameter values, the same as **list general**. The **list snr** option will list parameter values for SNR-related parameters and the **list procedure** option will list parameters related to procedures. The **list all** command will do just that, it will list all the parameters. The **list all** option was not made the default because there are too many parameters to fit on one screen.

To change the default value of any parameter, type the parameter name followed by the new value in the units shown in the list below. As many parameter names and values may be typed on one line as desired. Parameter names need not be fully typed out, just enough to make the name unambiguous.

The current values of default parameters are written into the $PARAM section of the schedule file when the **ec**, **er**, **wc**, or **wr** command is used. In later sessions, sked automatically sets these parameter values when it reads the schedule file.

Descriptions of each parameter are listed below, in alphabetical order. A display of all parameters with their default values is shown on page SKED-13. Refer to page SKED-20 to see how the parameters are used in sked's time line.

calibration Time allowed for calibration (in the SNAP **preob** procedure) after slewing and before observation start time, seconds. Default **10** sec.

change Time allowed for changing tapes, in seconds. Default **420** sec.

confirm **y** or **n**. If **y**, sked asks for approval before adding a new observation.

corsynch Time to allow the correlator to synchronize tapes, seconds. This time is added to all durations but not counted in SNR calculation. If you are using a non-zero **corsynch**, then early tape start must be 0 seconds (**early** command).

duration Default value for the duration of a scan, in seconds. This value is assigned to newly-selected sources. This is the time between start and end of "good data", *i.e.* exclusive of the early tape start. Refer to the **scan** command description.

experiment Experiment name, up to 8 characters. This name appears on the first line of the schedule following $EXPER. drudg prints this name in all its headers. This name is used as the root for the **solve** command output.

frequency Default frequency sequence, one of the codes selected with the **frequency** command.

head Time to allow for the **head** SNAP command to execute, seconds. Default **6** seconds.

idle Time to allow after the scan is over before starting to slew to the next source, in seconds. SNAP procedure **postob** is executed during this time. Default **0** sec.

lookahead Amount of time the **whatsup** command looks ahead for sources about to rise or set, in minutes. Default **20** min.

midob Name of SNAP procedure to be performed during a scan, max 6 characters. Default is **midob.**

midtp Time to allow for a mid-tape procedure, seconds. Default **10** sec.

minimum Minimum time between scan start times, in seconds. Default **0** sec.

minsubnet Minimum size of a subset of the full network that may be scheduled during automatic scheduling. Default **0**, i.e. use subconfiguration optimization. If non-zero, single scans will be selected for consideration based on mutual visibility and SNR.

This parameter uses the results of the **whatsup** command to determine the available observations and then selects the one with the highest weight.

minscan Minimum allowable scan time. Normally use 60 or 75 sec when **early** is used, otherwise 90 sec. Calculated scan times are set equal to **minscan** if the calculated value is smaller than **minscan**.

modscan Modular time for variable scan lengths. Calculated scan times are rounded up to the next unit of **modscan**. If **modscan** is **10** sec (default) then calculated scan lengths will be, *e.g.* 110 sec, 120 sec, *etc*.

modular The even time mark for automatic scheduling, in seconds. If the feature of automatic start time calculation by sked is used, the start time will be adjusted to the next occurrence of an even time. For example, if **modular** is set to 300 seconds (5 minutes) then scans will be scheduled only at 0, 5, 10, *etc*. minutes past an hour.

parity Time to allow for parity-checking procedure, in seconds. Default **70** sec.

postob Name of the SNAP procedure to be performed after an observation and before slewing to the next source, max 6 characters. Default is **postob**.

preob Name of the SNAP procedure to be used during the **calibration** time, max 6 characters. Default is **preob**.

prepass Time to allow for tape accommodation pass procedure, in seconds. Default **600** sec.

prflag Four-character string indicating whether or not time is to be included for each of four procedures (**setup**, **parity**, **prepass**, and **peak** respectively). **y** means yes and **n** means no. Refer to page SKED-20 which gives details on when each is used in the time calculations. The PEAK parameter was removed and so the fourth flag is ignored.

setup Time to allow for equipment setup SNAP procedures such as SX2C1, in seconds. Default **20** sec.

snr **auto** or **man**. Set to **auto** to automatically drop stations from a new observation if inadequate SNR is achieved on any baseline to that station. Set to **man** to be asked if you want to include that station anyway. The **whatsup** display will be affected by this parameter.

source Time to allow for processing the SNAP **source** command, seconds. Default **5** sec.

subnet The default subnet to be scheduled for each scan. Default is the complete list of selected stations. This parameter is updated to the full network each time you re-select stations.

sundis Minimum distance from the sun in degrees. Default **15** degrees. Source must be further from the sun than **sundis** for a valid scan.

synchronize Flag for synchronization of tapes, **on** or **off**. If **synchronize** is **on**, then the tapes are "synchronized" in the sense that scans are scheduled to be recorded at the same physical location on the tapes at each station, although not necessarily on the same pass for high density recorders. If **synchronize** is **off** (default setting), then scans are scheduled to be recorded on the next stretch of tape available at each station. Please refer to page SKED-102 for a discussion of subnetting.

tape Time to allow for the SNAP **tape** command, seconds. Default **1** sec.

vis **sub** or **all**. Set to **sub** if it's OK for a sub-set of stations to observe a source, and sked will drop stations automatically if the source is not up. Set to **all** to require all stations in the current **subnet** to participate. This parameter affects the **whatsup** display.

vscan **y** or **n**. Set to **y** to use SNR, SEFD, and source flux to compute scan lengths. Set to **n** to use scan length in **scan** command.

width Width of display (screen or printer) in columns. This determines the display width in the **sum** and **whatsup** commands and for source, station, and frequency selection displays. Set this parameter to **0** (default) for automatic sizing of displays to your window size. The actual value of the width will be

shown when you do a **`parameter list`** command. Defaults to 79 if you do not have an X display.

previous

Syntax: **previous** [*number*]

This command lists the previous scan(s) in the schedule. The list starts *number* of scans before the current scan and ends with the current one. If the current scan is less than *number* scans from the beginning of the schedule, the list starts at the beginning of the schedule and lists up to the current scan. A maximum of *number* plus one scan are listed. If *number* is not specified, the default is to list two scans, the previous one and the current one.

Other commands that allow you to move around in the schedule: **back** to move backwards in the schedule, **list** to go to an arbitrary scan, or **next** to move ahead one scan.

printl, printp

Syntax: **printl** [*file* * **print**]
printp [*file* * **print**]

This is the print command that is used following the **unit** command. A temporary print file is opened upon the first use of the **unit print** command and is located in the temporary directory specified in the control file. Refer to **unit** command description.

Printing is done using the landscape or portrait command string found in the sked control file for **printl** or **printp**, respectively.

If *file* is specified, that file is printed. If **print** is specified, then a file named /tmp/SKP*nnnnn* is printed where tmp is the name of the temporary directory in the control file and *nnnnn* is the process ID (pid) of the current running of the program. The pid is listed when you use the **parameters list** command.

If nothing is specified beyond the command, the default is to print whatever file is open. The file is first closed, then printed. Output is returned to the screen, and another **unit** command must be issued to set up printing to a file again. If no file is open, the default is /tmp/SKP*nnnnn*.

The temporary printing file is deleted after it has been printed out. *file* is considered a permanent file and is not deleted after printing.

result

Syntax: **result** [**fe** * **correlation** * **covariance**]

This command calculates and displays the formal errors (**fe** option), correlation matrix (**corr** option), or variance/covariance matrix (**cov** option). Also refer to the **solve** command which provides an interface to the standard VLBI analysis program `solve` for calculation of formal errors. See pages SKED-116 and SKED-119 for a list of what is calculated and displayed.

The **result** command can be used with any schedule, not only one generated with automatic scan selection. Formal errors for a schedule made interactively can be calculated with the following steps:

1) read in the schedule,
2) use the **op set** command to set parameters to be estimated,
3) use the **op go** to generate the normal equations, and
4) issue the **result fe** command.

A sample output listing:

```
   SKED results from file ./xpac93.skd for experiment XPAC93

Local sky coverage:  .3058

Observations from the last  24 hours are included.

Standard deviations of the unknown parameters:
      atm  ALASKANO      .5762D-03 m
      atm1 ALASKANO      .1210D-07 ms
      atm  KASHIM34      .4179D-03 m
      atm1 KASHIM34      .8598D-08 ms
      atm  KASHIMA       .3932D-03 m
      atm1 KASHIMA       .7787D-08 ms
      atm  KOKEE         .4936D-03 m
      atm1 KOKEE         .9621D-08 ms
      atm  MARCUS        .5875D-03 m
      atm1 MARCUS        .8702D-08 ms
      atm  SESHAN25      .7501D-03 m
      atm1 SESHAN25      .1383D-07 ms
```

```
      tau  ALASKANO      .5810D-11 s
      tau1 ALASKANO      .2182D-15
      tau2 ALASKANO      .2173D-20 /s
      tau  KOKEE         .5627D-11 s
      tau1 KOKEE         .2133D-15
      tau2 KOKEE         .2166D-20 /s
      tau  MARCUS        .9132D-11 s
      tau1 MARCUS        .2021D-15
      tau2 MARCUS        .2009D-20 /s
      tau  SESHAN25      .6099D-11 s
      tau1 SESHAN25      .2200D-15
      tau2 SESHAN25      .2259D-20 /s
      lon. MARCUS        .5945D-03 m
      lat. MARCUS        .6428D-03 m
      hgt. MARCUS        .2270D-02 m

sumtr=         .314040D-02
```

At the top of the list of parameters is the value of the sky coverage index for this schedule; see the discussion starting on page SKED-119. At the bottom is the value of the trace of the matrix, which could be used to discriminate among different schedules.

Refer to the discussion starting on page SKED-116 about the covariance analysis and the equations and algorithms used in `sked`.

remove

Syntax: **`remove`** *range station*

This command causes the named station to be removed from all scans in the given time range. The time range must be specified. If an incorrect scan is encountered, the station is still removed and execution of the **`remove`** command continues to the end of the specified time range. At present, only one station at a time may be specified in this command.

Refer to page SKED-17 for the syntax of *range* and *station*.

scan

Syntax: **scan** [*source time source time* ...]

This command is used to specify values for scan durations, also known as "scan lengths". The scan length for a source is set by default to the value of the **duration** parameter when the source is first selected with the **source** command. The scan time for a source is remembered once it has been set, even if you select other sources or de-select sources.

The *source* given in this command may be a source name or number. The *time* is in seconds. If *source* is the underline character _, then all sources receive the same value of *time*. The scan times are written into the $PARAM section of the schedule file when the **er**, **ec**, **wr**, or **wc** command is executed. The scan durations are then automatically set when the same schedule is accessed again.

If only the command name is typed, the current scan lengths are displayed.

Values for scan lengths are *ignored* if parameter **vscan** is set to **y**.

sitevis

Syntax: **sitevis** [*source* [*subnet* [**line** * **xyazel** * **polazel**]]]

This command displays the source visibility at each site as well as the mutual visibility between sites. In addition, the maximum elevation of each source at each station is displayed. Refer to the discussion under the **mutualvis** command; this display is a super-set of the **mutualvis** display.

Displays are produced on the display unit. Plots are identical to those produced for the **mutualvis** command.

A sample display for one source is shown below. This might be output from the command **site 2**.

```
Source Visibility on 93 83
for stations  FD-VLBA GILCREEK  KOKEE LA-VLBA  ONSALA60  WESTFORD  WETTZELL

2 0048-097 RISE  SET  MAX|0     3     6     9     12    15    18    21    |
           hh:mm hh:mm EL|------|-----|-----|-----|-----|-----|-----|-----|
D FD-VLBA  14:30  0:49 49|-|                           |------------------|
A GILCREEK 20:28  2:16 15|----|                                 |-------|
K KOKEEE   17:51  4:54 58|---------|                       |------------|
L LA-VLBA  14:41  1: 7 44|--|                          |------------------|
T ONSALA60  7:37 16:14 23|               |----------------|               |
E WESTFORD 12:33 22:26 37|                         |------------------|   |
V WETTZELL  7: 3 16:47 31|              |------------------|              |
All stat'ns 0: 0  0: 0   |44322          2222222223333555543444455555444|
```

The display shows the UT times that the source rises and sets at each station graphically, and the exact times are shown in `hh:ss` format. The maximum elevation that the source reaches at the station is also shown in integer degrees. The final line of the display shows the mutual visibility of the source with the full network. This is the same line that would be output with the **mutualvis** command.

snr

Syntax: **snr** [*subnet band value* * **margin** *band value*]

This command sets or lists the minimum SNR to be achieved by baseline and band. You can exclude a subnet from influencing the SNR calculations by specifying an SNR of **0**. The default value for all baselines is an SNR of 0. Refer to the equations starting on page SKED-106 to see how SNRs and scan lengths are calculated. Refer to page SKED-17 for the syntax of *subnet*.

Multiple subnets may be specified; they are read from left to right, and any baseline specified more than once will be set to the most recent *value* for it. Subsequent SNR commands will set only those baselines specified. For example, in a schedule with Fairbanks, Kokee, Westford and Onsala, you may want to reduce the SNR requirement on the relatively weaker Onsala-Westford baseline. A sample SNR command might be

```
snr _ x 30 ft-wf x 20
```

This command sets all baselines to achieve a minimum SNR of 35, and then the one baseline is set to 20.

If no parameters are given, the current values for SNR at both bands are listed. A sample display from the command **snr**:

```
Minimum SNR by baseline:
    X-band (margin   5)     S-band (margin   3)
    FT  KK  N2          FT  KK  N2
KK  20              KK  15
N2  20  20          N2  15  15
WZ  20  20  20      WZ  15  15  15
```

The **margin** keyword is used to specify a margin for checking calculated SNRs against the minimums. If the calculated SNR value is at least as large as the minimum less the margin then the scan is acceptable for scheduling. Note that **margin** is only useful when scan lengths must be comparable to a full tape length to achieve the required SNR. For example, if you want an SNR of 20 on a baseline involving a small antenna, a scan length on a weak source might have to be 784 seconds just to achieve

an SNR of 18. If you set a margin of 5, then the value of 18 will be acceptable and the scan length will be 784 seconds.

Values for SNR for each baseline are written into the $PARAMETERS section of the schedule file and are automatically read back into sked when you pick up the same schedule.

solve

Syntax: **solve** [*output-file-name*]

This command creates an output file with lists of the sources and stations for this schedule and the partial derivatives for each observation. If no output file name is specified, the output file is given the default name of *experiment*.solve where *experiment* is the name in the **parameter** command display, taken from the name on the $EXPER line in the schedule file.

Caution: The calculation of the partial for source declination appears to be correct in sked, but the value of the partial does not agree with partials in data bases. The problem has not yet been found. This may affect solutions which estimate source positions.

The output file is the sked side of the interface to solve. The other side of the interface is implemented in a program called sskedh (written by Karen Baver) which loads the information from the file into a set of solve work files or creates a superfile. You then run solve to set up parameterization and start the least squares processing, or set up a batch run. The README file for sskedh is found in the source directory for the program, wherever solve source code is installed on your machine. Please refer to this file for the latest version of the documentation.

sources

Syntax: **sources select * list * plot**

This command deals with the user's selected source list. The **select** option must be done to establish the list of sources to be considered for scheduling. The maximum number of sources which can be selected was set at the time that sked was installed on the computer you are using.

For source selection, sked opens the catalog file with source positions as given in the control file. sked displays the list of all source names from the source catalog on the screen a page at a time. Selection (or "deselection") of a source is done by placing the cursor somewhere on the desired source name and pressing the space bar. The source name appears in inverse video if the source is selected. To deselect a source, do the same thing as selecting the source. Move to the next page by selecting that option with the cursor.

CAUTION: You must use the h-j-k-l keys to move the cursor and NOT the arrow keys.

After selection, return to scheduling with one of the terminating options (see page SKED-104 on Catalog Access). Any source selected for the first time will have its scan length (see **scan** command) set to the current **duration** parameter value. Any source already selected will retain the scan length previously set with the **scan** command.

The **list** option for this command lists the selected source names and precessed positions on the display device. Source positions are precessed to 0 hours UT on the date that is current when the positions are input, *i.e.* when the schedule file is read or when selection is done. (The current date is displayed in the list of parameters.) Any source closer to the sun than parameter **sundis** degrees will be flagged in this listing. Source numbers and plot letters (see below) are listed. A sample (partial) listing:

```
   #     SOURCE      RA(hms) 2000 DEC(dms)     RA(hms) DATE DEC(dms)     RA(hms) 1950
DEC(dms)
   1 1  0016+731    0 19 45.8  +73 27 30.    0 19 20.6  +73 25 10.    0 16 54.2  +73 10
51.
```

```
   2 2  0048-097    0 50 41.3  - 9 29  5.    0 50 20.9  - 9 31 15.    0 48 10.0  - 9 45
24.
   3 3  0059+581    1  2 45.8  +58 24 11.    1  2 20.5  +58 21 58.    0 59 43.5  +58
8  4.
   4 4  0119+041    1 21 56.9  + 4 22 25.    1 21 35.9  + 4 20 17.    1 19 21.4  + 4
6 44.
   5 5  0208-512    2 10 46.2  -51  1  2.    2 10 30.1  -51  2 53.    2  8 56.9  -51 15
8.
0229+131 is less than  15 degrees from the sun, arc length =  3.0
   6 6  0229+131    2 31 45.9  +13 22 55.    2 31 23.8  +13 21  6.    2 29  2.5  +13
9 41.
   7 7  0454-234    4 57  3.2  -23 24 52.    4 56 46.0  -23 25 39.    4 54 57.3  -23 29
28.
   8 8  0458-020    5  1 12.8  - 1 59 14.    5  0 52.5  - 1 59 56.    4 58 41.3  - 2
3 34.
   9 9  0528+134    5 30 56.4  +13 31 55.    5 30 33.8  +13 31 33.    5 28  6.7  +13 29
42.
  10 a  0537-441    5 38 50.4  -44  5  9.    5 38 37.7  -44  5 37.    5 37 21.1  -44
6 45.
  11 b  0552+398    5 55 30.8  +39 48 49.    5 55  3.0  +39 48 49.    5 52  1.4  +39 48
22.
  12 c  0727-115    7 30 19.1  -11 41 13.    7 30   .8  -11 40 36.    7 27 58.1  -11 34
53.
```

The **plot** option produces a graph showing the position of each source on a plot of declination *vs*. right ascension. The position of the sun on the schedule date is plotted as an **S** and the position of the sun through the year is plotted as *****s. Sources are identified by letter, as shown in the **list** option.

When the scheduling session is completed and the **ec**, **er**, **wc**, or **wr** command is issued, the sources which are currently selected are written out into the schedule file if selection has been done.

Refer to the **sked Catalog** manual for the source catalog format.

stations

Syntax: **stations select * list**

This command allows the user to select antennas for scheduling. sked opens the catalog file with antenna names as specified in the control file. It displays all of the antenna names found there. Select stations by placing the cursor on the name of the desired station and press any key. The name will be highlighted when it is selected.

> *CAUTION: You must use the h-j-k-l keys to move the cursor and NOT the arrow keys.*

When you return to the program, sked reads information from catalog files antenna.cat, position.cat, equip.cat, and mask.cat. Any stations selected from the catalog that have duplicate one-letter ID codes will be automatically assigned new letters by sked so that each ID is unique within the schedule. This is the only requirement of the correlator software: that each station's ID be unique within the schedule. For example, the ID for Kauai is K in the antenna catalog, and so is the ID for Kokee. When both are selected, Kauai retains the K because it is the first name encountered in the catalog and Kokee is assigned the next letter in the alphabet, L.

The default ID assignment can be overridden by typing in the letter you desire when selecting the station. To use this feature, move the cursor to the station ID letter and type the letter you want. The station will retain this ID even if you go back to re-select stations.

After station selection, the default subnet is re-initialized to include all the stations selected. The default subnet can be changed via the **parameters subnet** command. The minimum elevation for each newly-selected station is set to 5 degrees. Use the **elevation** command to change the horizon (elevation) limit at each station. Any station which had already been selected will retain the elevation limit previously set with the **elevation** command.

The **list** option displays information about the stations. There are multiple parts to the display. The first part shows the station pointing limits, horizon mask, and slew rates.

```
STATION     AXIS  SLEW RATES   SLEW CONST  LIMIT STOPS
```

```
 1 D FV FD-VLBA   AZEL  90.0 30.0    0    0    270.0    810.0      2.3     90.0
                  103.94 WEST         30.64 NORTH   Occupation code: 76139801
                HORIZON:    0.  5.0  20.  3.0  40.  2.0  60.  7.0  75.  4.0
                            85.  6.0 100.  2.0 225.  4.0 230.  2.0 245.  3.0
                           255.  5.0 270.  4.0 280.  3.0 285.  2.0 290.  4.0
                           310.  5.0 315.  2.0 325.  6.0 345.  5.0 360.
 2 A AL GILCREEK  XYNS  60.0 60.0    0    0    -86.0     86.0    -73.5     73.5
                  147.50 WEST         64.98 NORTH   Occupation code: 40476601
                HORIZON:    0. 17.0  10. 14.0  20. 10.0  35.  8.0  48.  6.0
                            57.  5.0  87.  6.0  93.  8.0 110. 10.0 127. 12.0
                           165. 14.0 170. 17.0 185. 16.0 190. 14.0 195. 12.0
                           200. 10.0 205.  8.5 214.  7.4 220.  6.5 230.  5.0
                           290.  7.0 305. 10.0 320. 11.5 344. 14.0 350. 17.0
                           360.
 3 K KK KOKEE     AZEL 120.0120.0    2    2    270.0    810.0       .0     89.7
                  159.67 WEST         22.13 NORTH   Occupation code: 72983001
 4 L LA LA-VLBA   AZEL  90.0 30.0    0    0    270.0    810.0      2.3     90.0
                  106.25 WEST         35.78 NORTH   Occupation code: 76119601
                HORIZON:    0.  2.0 130.  3.0 150.  2.0 250.  3.0 300.  4.0
                           320.  3.0 340.  2.0 360.
 5 T O6 ONSALA60  AZEL 144.0 60.0   20   10    340.0    740.0      5.0     85.0
                  348.07 WEST         57.40 NORTH   Occupation code: 72137701
 6 E WF WESTFORD  AZEL 240.0180.0    0    0    100.0    460.0      4.0     87.2
                   71.49 WEST         42.61 NORTH   Occupation code: 72097301
                HORIZON:    0.  5.0  15.  6.0  25.  8.0  60.  5.0  75.  6.5
                            85.  5.0  95.  6.5 105.  5.0 115.  4.0 360.
 7 V WZ WETTZELL  AZEL 180.0 90.0    0    0    270.0    810.0      2.0     89.0
                  347.12 WEST         49.15 NORTH   Occupation code: 72247801
                HORIZON:    0.  4.5   5.  3.5  25.  3.0  35.  4.5  77.  3.0
                           112.  4.0 140.  3.0 185.  4.0 215.  2.5 225.  2.0
                           230.  1.0 290.  2.5 300.  4.0 318.  5.0 340.  4.5
                           355.  5.0 360.
```

The second part of the display shows the baseline lengths, first in matrix form and then in a list sorted by baseline length.

```
 Baseline lengths (km):
                FV     AL     KK     LA     O6     WF
          AL  4726.
          KK  5409.  4728.
          LA   609.  4158.  5200.
          O6  7941.  6066.  9793.  7634.
          WF  3135.  5040.  7676.  3044.  5601.
          WZ  8418.  6857. 10357.  8162.   920.  5998.

 Average baseline length =  5784. km

 LA-VLBA  - FD-VLBA       609.
 WETTZELL - ONSALA60      920.
 WESTFORD - LA-VLBA      3044.
 WESTFORD - FD-VLBA      3135.
 LA-VLBA  - GILCREEK     4158.
 GILCREEK - FD-VLBA      4726.
.....
```

```
ONSALA60 - KOKEE        9793.
WETTZELL - KOKEE       10357.
```

The third part of the display shows the equipment characteristics such as SEFDs, type of terminal, and tape.

```
   ID  STATION   Band SEFD   Band SEFD  DAT name  ID  #Passes Tape length Max Scan
D FV  FD-VLBA    X    500.  S    400.  FD-VLBA  FV      14     17640(2)    784
               X     .50     .73     .27
               S     .10   -2.09    3.09
A AL  GILCREEK   X    750.  S    800.  MOJ-VLBA 101     12      8820(1)    392
               X    1.00     .95     .05
               S    1.00     .97     .03
K KK  KOKEE      X   1200.  S    750.  KO-VLBA  102     12      8820(1)    392
               X    1.00     .95     .05
               S    1.00     .97     .03
L LA  LA-VLBA    X    500.  S    400.  LA-VLBA  LA      14     17640(2)    784
               X    1.00     .93     .07
               S     .10   -2.26    3.26
T O6  ONSALA60   X   2450.  S   3200.  ONSALA     2     12      8820(1)    392
               X     .50     .78     .22
               S     .20     .42     .58
E WF  WESTFORD   X   1500.  S   1400.  WESTFORD   7     12      8820(1)    392
               X    1.00     .94     .06
               S    1.00     .96     .04
V WZ  WETTZELL   X    750.  S   1115.  WETTZELL  33     12      8820(1)    392
               X    1.00     .95     .05
               S    1.00     .93     .07
```

See page SKED-104 for a complete sked-catalog interaction description. Refer to the **sked's Catalogs** manual for the formats of the catalogs that hold station information.

subcon

Syntax: **subcon** [**on** * **off**]

This command specifies whether subconfigurations are displayed as they are being evaluated during the **whatsup** command.

If **subcon** is **off** (initial default setting) then no display is made.

If **subcon** is **on** then each subconfiguration is listed on the display device just before it is evaluated during automatic scan selection.

summary

Syntax: **summary** [*range* [*source* [*subnet* [**stats** * **line** * **baseline** * **hist** * **snr** * **xyazel** * **polazel** * **el** * **az** * **coverage** | **file** [*xmin xmax ymin ymax*]]]]]

A summary of the specified observations is displayed on the display unit. The summary can be restricted to a certain time range, to a single source, and/or to a subnet of stations. The default is to summarize all observations. Refer to page SKED-17 for a description of *range*, *source*, and *subnet*. The specifications for time, source, and stations must appear in order as shown in the syntax above. The place-holder character **_** (underline) can be used to indicate "all" if, for example, you want to summarize all observations for a single source. The output produced by each of the key words is described next.

Printed displays. The **stats** option (default) displays the statistics of time spent in observing, calibration, slewing, and the total number of tapes required. The observations for each baseline in the subnet are summarized. The number of observations using 2, 3, 4, *etc.* stations is listed. A sample display follows.

```
SKED Summary from file ../schedules/rd9405.skd for experiment RD9405

     (all scans with at least one subnet station)


Average number of observations per baseline (normalized by up-time) =   7.2
Min =    .0   Max =   67.0 (Baseline AL-KK on 0048-097)   RMS =   7.3

Total time:       1440 minutes ( 24.0 hours).

Key:     FV=FD-VLBA    AL=GILCREEK   KK=KOKEE      LA=LA-VLBA    O6=ONSALA60
         WF=WESTFORD   WZ=WETTZELL

                 FV  AL  KK  LA  O6  WF  WZ  Avg
% obs. time:     32  26  32  30  31  27  28  29
% cal. time:      3   3   3   3   3   3   3   3
% slew time:     29  24  16  29  20  10  12  20
% idle time:     34  44  48  36  45  58  55  46
# MK III tapes:   2   5   6   2   6   4   5
total # scans:  326 320 273 328 265 280 293 297
```

```
 # scans/hour :   13  13  11  13  11  11  12  12
 Avg scan (sec):  85  72 102  80 102  85  84  87


      # OF OBSERVATIONS BY BASELINE

   | FV  AL  KK  LA  O6  WF  WZ   StnTotal
 ----------------------------------------
 FV|326 214 195 280 106 215 118      985
 AL|    320 217 220 125 168 143     1339
 KK|        273 198  71 133  74      912
 LA|            328 110 212 123      884
 O6|                265 144 240     1044
 WF|                    280 169      788
 WZ|                        293      998


 Number of  2-station scans:  173
 Number of  3-station scans:  110
 Number of  4-station scans:  100
 Number of  5-station scans:  119
 Number of  6-station scans:   20
 Number of  7-station scans:   42

 Total # of scans, observations:   564    3475
```

The **`line`** option produces a time-line display which summarizes a schedule by source. For each source, the total number of scans scheduled for that source is listed and a time line indicates when the scans are scheduled. The second part of the display is the same as the output for the **`stats`** option. A fragment of a sample display of the source lines:

```
   SKED Summary from file ../schedules/rd9405.skd for experiment RD9405

      (all scans with at least one subnet station)

  SOURCE |0           6           12          18           | #SCANS #OBS
#Obs/bl
 0048-097I x  x x x  x  x xx x    x xx  xx x  x          I    16    63  12.7
 0059+581Ixx  x xx xxxx x x x   x x  x x xx  x x x x x x xI    26   328  18.2
 0119+041I      xx x x   x x xxx xx  x xx x xx x  xx    x I    21    84   8.4
 0229+131I   x  x x x    x x x   x x x x x  x x xxx x x xxI    23    82   7.3
 0454-234I            xx x x x  x x  x     x   x x       I    11    26   5.5
 0458-020I       x  x x     x   x  x x x x xxx x x xxx  x I    18    99  10.8
 0528+134I   x x  x  x   x x x xx x x  x xxx  x x  x   x  I    22   135  12.0
 0537-441I                              x  x  x xx        I     5     7   2.0
.......
 Total scans, obs:                                          564  3475
```

```
 Average number of observations per baseline (normalized by up-time) =   7.2
 Min =    .0   Max =   67.0 (Baseline AL-KK on 0048-097)   RMS =   7.3
```

If parameter **`width`** is greater than 79 columns, an expanded display is produced for the **`line`** option. This display gives twice the time resolution as the normal display, and the line for each source contains an R and an S to mark the mutual rise and set times of that source for the entire subnet.

The **`baseline`** option displays a matrix of the number of observations for each source for each baseline in the specified subnet. The second part of the display is the same as the output for the **`stats`** option.

The **`hist`** option displays information about the elevation distribution of scans and observations. There are three parts to the display. The first part is a numerical histogram of the distribution of elevations of scans at each station, with a bin size of 5E.

```
   SKED Summary from file ../schedules/rd9405.skd for experiment RD9405

      (all scans with at least one subnet station)

Elevation histogram
 Distribution of elevations, for each station
    Elev:  0   5  10  15  20  25  30  35  40  45  50  55  60  65  70  75  80  85  90
FD-VLBA :    8  33  21  26  28  28  31  23  23  19  15  20  17  16   5  10   1   2
GILCREEK:    0  21  21  31  32  41  36  22  22  15  21  17  17  11   8   4   1   0
KOKEE   :   12  21  11  13  19  21  21  24  15  15  21  18  19  12  22   6   2   1
LA-VLBA :   16  37  17  20  33  26  24  24  23  21  22  19  17  10   6   5   7   1
ONSALA60:    0  48  17  24  25  12  23  13  21  12  13   9  14  11  14   6   3   0
WESTFORD:    7  33  20  27  16  25  25  18  21  19  22  16  12   3   8   5   2   1
WETTZELL:    6  44  24  27  21  23  13  23  18  22  14  12  14   5   8  12   6   1
   Total:   49 237 131 168 174 176 173 147 143 123 128 111 110  68  71  48  22   6
Total number of station scans:  2085
```

The second part shows the distribution of elevations in 1E bins from 0E to 10E to allow a more detailed examination of low-elevation scans at each station.

```
    Elev:  0   1   2   3   4   5   6   7   8   9  10
FD-VLBA :    0   0   0   4   4   7   7   6   8   5
GILCREEK:    0   0   0   0   0   2   5   3   5   6
KOKEE   :    0   0   0   2  10   3   3   6   3   6
LA-VLBA :    0   0   0   5  11   8   5   6   6  12
ONSALA60:    0   0   0   0   0   8  12  12  11   5
WESTFORD:    0   0   0   0   7   4   8   7   7   7
WETTZELL:    0   0   0   3   3  13   7   7   8   9
   Total:    0   0   0  14  35  45  47  47  48  50
Total number of station scans:   286
```

The third part concerns observations. The elevation cutoff option in `solve` considers an observation to be below the cutoff if one or both participating stations are observing at or below that elevation. The display shows the distribution of observations in the schedule below 10E.

```
Distribution (one or both stations are observing at low elevation)
Elev:  0    1    2    3    4    5    6    7    8    9   10   Total
          0    0    0   41   92   94   82   87   88  105      589
                  0>>|    133>>|    309>>|
                   0%         3%         8%                    16%
```

The **`snr`** option displays a numerical histogram of the distribution of SNRs on each baseline. The bin size is 5 units of SNR, from 0 to 85. SNRs greater than 85 are put into the last bin. A separate display is produced for the two bands (X, S).

```
   SKED Summary from file ../schedules/rd9405.skd for experiment RD9405

      (all scans with at least one subnet station)

SNR histogram
 Distribution of X-band SNRs, for each baseline
 SNR:  0   5  10  15  20  25  30  35  40  45  50  55  60  65  70  75  80  85  >>
 FV-AL:   0   0   0   0   0  14  20  24  11  36  12   4   3   5   1  11  16  57
 FV-KK:   0   0   0   0   0  38  22  20   6  14   6   7  17   3   2   7   9  44
 FV-LA:   0   0   0   0   0   0   2  12  10  18  10  11  18  13  17  19  15 135
 FV-O6:   0   0   0   2   0  43  13  12   5   8   2   5   4   1   1   1   4   5
 FV-WF:   0   0   0   0   0  23  36  29  22   4   6  14  18   1   2   8   6  46
 FV-WZ:   0   0   0   0   0  28  13  21   3   0   7   4   8   4   1   7   2  20
 AL-KK:   0   0   0   0   0   0  28  24  17  24  19   2   4   0   2   7  23  67
 AL-LA:   0   0   0   0   0  11   7  31  18  15  30   6   3   4   4   4  21  66
 AL-O6:   0   0   0   1   0   0  57   3   0   2  19   2   3   7   3   0   0  28
 AL-WF:   0   0   0   0   0   0  25  22  24  15   3   2   1  10  19   2   2  43
 AL-WZ:   0   0   0   0   0   0  10   7  25   3  30  10   1   1   0   1   1  54
 KK-LA:   0   0   0   0   0  35  23  16  15  15   5   4  16   8   0   5   9  47
 KK-O6:   0   0   1   0   0   1  52   6   3   3   2   2   0   1   0   0   0   0
 KK-WF:   0   0   0   0   0   0  61   6   7   8  11   7   8   1   2   2   3  17
 KK-WZ:   0   0   0   0   0   0  35   7   2  13   0   5   3   6   1   0   1   1
 LA-O6:   0   0   0   2   0  40   8  22   4   9   2   3   3   2   1   3   1  10
 LA-WF:   0   0   0   0   0  25  22  27  30   2   5  14  21   2   1   8   8  47
 LA-WZ:   0   0   0   0   0  24  10  25   7   0   2   6  10   5   5   3   4  22
 O6-WF:   0   0   0   0  45  19   7  23   5   7   9   2   0   2   3   3   2  17
 O6-WZ:   0   0   0   0   0   0  54  19  34   5   5   7  25   6   6   8   4  67
 WF-WZ:   0   0   0   0   0   0  36  14  31   4   4   2  11  14   4   4   5  40
 Total   0   0   1   5  45 301 541 370 279 205 189 119 177  96  75 103 136 833
 Total number of obs:  3475  Average SNR:   75.1   Median SNR bin:  50
 Distribution of S-band SNRs, for each baseline
 SNR:  0   5  10  15  20  25  30  35  40  45  50  55  60  65  70  75  80  85  >>
 FV-AL:   0   0   0   7   2   2  11  10  24  31  15  16  22  29   9   6   4  26
 FV-KK:   0   0   0   0   6   5   9  12  13  10  11  21  24  17  16   3   7  41
 FV-LA:   0   0   0   0   1   5   9   4   6  13  11  11  10  18  13  19  18 142
```

```
 FV-O6:   0   0   6   4   5  50  16   9   6   3   3   3   0   1   0   0   0   0
 FV-WF:   0   0   0   5   5  12  22  26  28  18  40  12   6  11   3   1   3  23
 FV-WZ:   0   0   0   1  10   9  13  23  14  19   9   7   2   2   3   1   2   3
 AL-KK:   0   0   0   0   3   1  13  12  22  29   6  16  28  23  21   3   6  34
 AL-LA:   0   0   0   7   2   3  12  10  22  30  10  14  25  24  20   5   7  29
 AL-O6:   0   0   1   4  41  19  28   5   0   7   8   2   7   2   1   0   0   0
 AL-WF:   0   0   0   1   6   7  20  31  24  29  23   5   7   0   0   0   7   8
 AL-WZ:   0   0   0   1   4  10  19  39   7   8  26   0   9   0   4   4   1  11
 KK-LA:   0   0   0   0   6   3  11   8  20   8   9  22  28  18  18   2   8  37
 KK-O6:   0   0   5   0   1  18  17  20   9   0   0   0   0   1   0   0   0   0
 KK-WF:   0   0   2   1   7   5  11  17  11  33  13   6   7   5   5   2   4   4
 KK-WZ:   0   0   1   1   2   0   8  31  13   4   0   8   0   0   1   0   0   5
 LA-O6:   0   0   3   7  13  38  19   6  11   4   5   1   2   0   0   0   0   1
 LA-WF:   0   0   0   6   5  10  19  24  25  26  35  15   4  10   5   2   3  23
 LA-WZ:   0   0   1   1   8   9  13  21  19  22   4   8   3   5   2   1   2   4
 O6-WF:   0   0  10  28  60  23   5   8   3   2   5   0   0   0   0   0   0   0
 O6-WZ:   0   0   9  32  55  47  34  14  14   9  12   3   3   5   3   0   0   0
 WF-WZ:   0   0   2   3  14  22  39  22  31  10   1   4   6   6   2   1   5   1
 Total   0   0  40 109 256 298 348 352 322 315 246 174 193 177 126  50  77 392
 Total number of obs:  3475  Average SNR:   52.5   Median SNR bin:  50
```

The **`coverage`** option displays a summary of the distribution of observations on the sky. There are three parts to the display:

1) The sky is divided into five parts of approximately equal area, called NW, SE, SW, NW, and UP. These are the four quadrants of the usual polar sky plots plus a central area that includes all elevations above about 53 degrees. The numerical histogram displays the number of scans that each station observes in each of the five areas. The total, average, and rms are also provided. A sample display:

```
   SKED Summary from file ../schedules/rd9405.skd for experiment RD9405

      (all scans with at least one subnet station)

Sky coverage histogram
            NE  SE  SW  NW  UP   Total  Avg   Rms
FD-VLBA :   54  56  68  71  77    326.   65.    9.
GILCREEK:   48  69  74  62  67    320.   64.    9.
KOKEE   :   43  56  24  61  89    273.   55.   21.
LA-VLBA :   60  56  67  74  71    328.   66.    7.
ONSALA60:   51  51  62  38  63    265.   53.    9.
WESTFORD:   48  63  61  51  57    280.   56.    6.
WETTZELL:   66  47  69  46  65    293.   59.   10.
 Overall     Avg=   60.  Rms=   12.
```

2) Each of the four quadrants is further divided into bins by elevation, with all bins having approximately equal areas. The second part of the display shows this distribution. The numbers in the first display can be obtained by summing the first four elevation bins for each direction, and summing

the highest elevation bin from each quadrant for the UP area. The sample below is from the same schedule as the sample above.

```
                    NE                    SE                    SW                    NW
       Avg Rms
  El bin:0  11  23  36  53  |0 11  23  36  53  |0 11  23  36  53  |0 11  23  36  53
|
FD-VLBA : 10  14  16  14  13|11  12  19  14  23|13  15  20  20  26|15  17  20  19
15| 16. 4. GILCREEK:  6  10  20  12  10| 5  23  28  13  17|11  18  24  21  23| 8  15
24  15  17| 16. 6.
KOKEE   : 12  11  12   8  15| 8  12  18  18  31| 0   1   7  16  21|15  14  16  16
22| 14. 7.
LA-VLBA : 15  15  17  13  10|13  13  14  16  26|15   9  20  23  18|15  18  22  19
17| 16. 4.
ONSALA60: 15  12  11  13  11|18  12  12  12  19|14  20  16  12  20| 8   8  13   9
13| 13. 3.
WESTFORD: 10   6  18  14  20| 8  15  18  22  12| 9  20  16  16  15|17  13  13   8
10| 14. 4.
WETTZELL: 18  15  15  18  16| 5  16  12  14  15|12  24  15  18  17|16  12   8  10
17| 15. 4.
    Avg:  12  11  15  13  13| 9  14  17  15  20|10  15  16  18  20|13  13  16  13
15|
 Overall     Avg=   15.  Rms=    5.
```

3) The spherical distances are computed between all pairs of observations on the sky at each station. The bin size is 10 degrees, the maximum distance being 180 degrees. These values have been used by importing them to a plotting program. The shape of the distribution of these values has been instructive in judging whether a sky distribution is "clumpy" or "smooth." If the distribution of observations on the sky is clumpy then the shape of the distribution is skewed toward smaller distances. The sample:

```
Histogram of distances between pairs of observations
FD-VLBA :232 1712 3194 4424 5423 5617 5773 5735 5313 4833 4113 3371 2508 1816 1045
601 214 21
GILCREEK:216 1834 3211 4454 5420 5549 5810 5608 5279 4876 4030 3263 2417 1626  846
364 138  5
KOKEE   :186 1370 2327 3271 4005 3941 3889 3645 3175 2957 2294 1838 1308  907  506
291 113 23
LA-VLBA :216 1737 3134 4379 5380 5613 5884 5809 5570 5038 4377 3736 2766 2031 1211
709 315 65
ONSALA60:129 1045 1853 2502 3236 3458 3613 3327 3126 2892 2411 1977 1358 1208  686
392 181 17
WESTFORD:174 1293 2295 3148 3925 4071 4091 4077 3845 3592 2980 2704 2081 1498  871
494 178 11
WETTZELL:184 1440 2559 3427 4373 4681 4822 4736 4389 3954 3240 2808 2075 1614  949
528 234 43
```

Plots. The **xyazel**, **polazel**, **el**, and **az** options produce graphics plots. Up to eight graphs are produced. All graphs appear on the screen at the same time. If the command **unit print** has been issued, then the plots are sent to the printer.

xyazel: This option produces a plot of elevation vs. azimuth, one point for each selected scan. Each plotted point is the number or letter of the observed source. The station's horizon mask is plotted as a line.
polazel: This option produces a polar projection with one point for each scan. Azimuth extends around the plot from 0 degrees in the north. Elevation is 90 degrees in the center of the plot and 0 degrees is the outer circumference. The azimuth and elevation of each scan is plotted as the number or letter of the observed source. The station's horizon mask is shown as a line.
el: This option produces a plot of source elevation vs. time for the selected scans.
az: This option produces a plot of source azimuth vs. time for the selected scans.

All default plot scales are 0 to 90 degrees for elevation (y-axis), 0 to 360 degrees for azimuth (x-axis), and 0 to 24 hours (x-axis). The optional parameters *xmin, xmax, ymin,* and *ymax* can be used to limit the plot scales. Units are degrees for elevation and azimuth, hours for time. Only points falling within the minimum/maximum range are plotted.

File. The **file** option was created as a test option and is not normally used. It will create an output file with data suitable for input to certain plotting programs. The file is written into a file with the name `/tmp/SKplot`, where `tmp` is the name of the temporary directory. The file contains lines in the following format:

```
Fields:  StnCode   SourceNum   Az(deg)   El(deg)   UT(hr)
Example:     A        13        196.3     42.1   12.36
```

tagalong

Syntax: **tagalong** *range station* [*stationx*]

This command will cause the named *station* to be added to all possible scans in the given time range. Refer to page SKED-17 for the syntax of *range* and *station*. The syntax for *stationx* is the same as for *station*.

Each observation in the time range is first checked to see if it is a valid scan for the other stations. If it is not, the process stops. The slew time, tape spin and change times and tape footage counter are all computed for the station being **tag**ged along. The station is then added to the scan if all elements are valid.

If the schedule was originally created using variable scan lengths, there are two options for tagging along a new station. If you set parameter **vscan** to **y** then the appropriate scan length for the new station will be calculated using the SNRs specified. If you set parameter **vscan** to **n**, then the station will be tagged along to each scan with the longest scan length of the subnet that participates in that scan.

As with **autoshift**, **check** and **remove**, the first scan in the time range is assumed to be correct. Only one station may be "tagged" at a time. The tagging process stops if an incorrect scan is encountered. Refer to page SKED-103 for a discussion of the things `sked` checks for a valid scan. Messages detailing the problems which may occur are typed out before the offending scan is displayed. During the **check**, **autoshift** and **tag** commands the assumption is made that the previous scan which was listed has passed inspection and is problem-free. Before `sked` attempts to add the new station to a scan it checks to see if the scan is valid. If it is not, the relevant messages are typed out and execution of the command stops.

The second, optional, *stationx* is the "tag-to" station. Only scans containing this station will be considered for tagging on the first station. This option is useful if you want to have a nearby alternate station participate in the scans already scheduled for another station.

tape

Syntax: **tape** [*station value [gap] station value* [gap] ...]

This command allows you to set the tape motion type that you want to use at each station. You can specify one type to apply to all stations or you can set each station's type individually.

The tape motion type is entered as *value* in this command. Valid type for tape motion are:

start&stop	The tape is started at the beginning of each scan and stopped at the end. Fast forward or fast reverse motion may be used to move the tape at high speed to the end of a pass if the next scan's duration is too long to fit in the remaining tape on the current pass.
continuous	The tape is started at the beginning of a pass and stopped only when the end of the pass is reached. The tape is never moved at high speed but is always moved at record speed.
adaptive	The tape is started at the beginning of a pass and stopped only if the time from the end of one scan until the start of the next scan is longer than the time specified by *gap*.

Refer to the discussion about tape usage starting on page SKED-109 for more details about tape motion and how scans are scheduled.

All stations are defaulted to type **start&stop** when stations are first selected from the catalog. Thereafter, the values set with this command are remembered even if you select another station or de-select a station.

Refer to page SKED-17 for the syntax of *station*.

If only the command name is typed, the current tape motion types are displayed. Sample:

```
ID  STATION  TAPE MOTION
FD  FD-VLBA    START&STOP
GC  GILCREEK   START&STOP
KK  KOKEE      START&STOP
```

```
WF  WESTFORD    START&STOP
WZ  WETTZELL    START&STOP
```

The tape motion types are written into the $PARAM section of the schedule file when the **er**, **ec**, **wr**, or **wc** command is executed and the limits are then automatically set when the same schedule file is accessed again. The types are found on the lines that start with TAPE_MOTION.

timeline

Syntax: **timeline** [**on** * **off**]

This command turns on/off a display of all the time elements used to determine and check scan start times. **timeline** is useful primarily as a tool for understanding exactly why SKED chose to start an scan at a certain time.

When **timeline** is **on**, a detailed display appears when you schedule a new scan or when you check or autoshift a set of scans.

The following is an example of the **timeline** display. The first line lists the first scan. Each subsequent group of four lines lists information for one station. The final line lists the next scan. Refer to the timeline display and algorithm discussion on page SKED-20.

```
         Source      Start     DURATIONS
         name     yyddd-hhmmss   A   H   M   X   Y
Obs 1    1633+38  90015-160000| 470 190 784 160 784|
line 1    STN  START  DUR TAPE IDLE SOURCE MAXSLEW CAL TAPE START
line 2   H  16: 3:10   0    1    0      5      96  10    1 16: 5:10
line 3    MAXSLEW=SLEW *OR* +PARITY+SETUP+HEAD
line 4             55           70    20    6
line 1   STN  START  DUR TAPE IDLE SOURCE MAXSLEW CAL TAPE START
line 2    X  16: 2:40   0    1    0      5      96  10    1 16: 4:40
line 3   MAXSLEW=SLEW *OR* +PARITY+SETUP+HEAD
line 4             37           70    20    6
Obs 2    1611+343 90015-160510|     100     100    |
```

A brief explanation of the contents of each line:

Obs 1 is the first observation from which procedure times and slewing times are calculated.

line 1 and line 2:

STN	Station ID
START, DUR	Combined, show the time that this station is available to begin a new observation.

TAPE, IDLE, SOURCE	Time (seconds) allowed for commands following the scan: TAPE command, POSTOB procedure, SOURCE command.
MAXSLEW	Maximum of slewing time or the sum of required commands (from lines 3,4).
CAL, TAPE	Time (seconds) allowed for commands before the scan: PREOB procedure, TAPE command.
START	The earliest time the next observation can start at this station.

line 3 and line 4:
The slewing time and the required command times are displayed on these two lines. The largest of the slewing time or the sum of the command times is displayed in lines 1,2.

SLEW	Time required for antenna to move to next source.
SPIN, PARITY, SETUP, HEAD, *etc*.	Time for required commands (only non-zero command times are displayed).

Obs 2 is the scan following Obs 1. If everything checks OK, then the start time for Obs 2 should be the latest of the station start times shown at the right end of lines 1,2.

unit

Syntax: **unit** [**print** * **screen** * *file* [**append** * **overwrite**]

This command sets the display unit for listings and other displays. Information messages, error messages, and help messages are always written to the screen. The default unit for display is the user's terminal. If the **unit** command is given with no parameters, the current display unit is shown.

To save output to be sent to a printer, type the command **unit print**. This will save all standard output (except command error messages) to a temporary file named /tmp/SKP*nnnnn* where *nnnnn* is the process ID. When you are finished saving output, type **unit screen**. This restores screen output but does not close the temporary file. The temporary print file can be added to anytime prior to its being printed by using **unit print append**. You can start the print file over again (without printing it) by specifying **overwrite** instead of **append**. The **append** option is the default. If you attempt to exit from sked without closing the temporary file you will be asked whether to abandon it or not.

Output to a permanent *file* works the same way as temporary output. An error is produced if you don't have permission to write to *file*. If you exit from *sked* before closing this file, you will be asked whether to ignore it or not.

To print the output, refer to **printl** and **printp** commands.

A session of saving output might look like this:

```
? unit print
 Saving to /tmp/SKP01177
? mu
? unit screen
 Closing file /tmp/SKP01177
  Output returning to the screen
? printp
  request ID is laser-160
Deleting file /tmp/SKP01177
?
```

The output from the **mutual** command will now be sent to the laser printer. The temporary print file is deleted.

untag

Syntax: **`untag`** [*range*]

This command will remove from the scans in *range* any station for which the source is below the horizon. Scans with sources below the horizon could have been generated by using the **`vlba`** command which makes a “full observe” schedule.

vlba

Syntax: **vlba** [**on** * **off**]

This command turns on/off the "full observe" mode that is sometimes used for experiments that will be processed at the VLBA correlator. This mode is not necessary because the VLBA correlator can handle fully subnetted schedules now, whereas in the past it could not.

When this mode is active, all participating stations will be scheduled for a scan even if the source is below the horizon for some of the stations. The minimum number of stations that must be able to see the source is specified with the parameter **minsubnet**.

After you use this mode to generate the schedule, you can then use the **untag** command to remove the stations that cannot see the source. This will produce a schedule that contains the observations that should come unflagged from the VLBA correlator. The "untagged" schedule can also be used for checking the simulation results from the experiment. The full schedule must be used for observing.

vscan

Syntax: **vscan** [*source* [*subnet*]]

This command calculates and displays scan lengths for the specified *source* for each station in the specified *subnet*. The command also displays theoretical SNRs for each baseline. If no subnet is specified, the current default subnet is used. If no source is specified, information for all sources is displayed.

If source is specified as **_**, a display is produced which lists all sources and baselines.

For a single source, the display consists of station scan lengths plus a matrix showing the calculated SNR for each baseline in the subnet. Error messages are displayed which detail inadequate SNR on individual baselines, as compared to the minimum SNRs specified with the **snr** command. The following is a sample display from the command **vscan 1**.

```
Variable scan info for 0048-097
Station:     FV   AL   KK   LA   O6   WF   WZ
Duration:   180  100  215  175  215  190   95
SNR by baseline:
         X-band               S-band
    FV  AL  KK  LA  O6  WF          FV  AL  KK  LA  O6  WF
AL  45                          AL  30
KK  47  45                      KK  41  30
LA  78  46  47                  LA  59  30  41
O6  30  30  30  30              O6  19  14  19  19
WF  44  40  40  44  30          WF  31  21  29  31  15
WZ  39  52  35  39  33  38      WZ  23  23  21  23  12  17
Observed flux by baseline:
         X-band                    S-band
      FV   AL   KK   LA   O6   WF            FV   AL   KK   LA   O6   WF
 AL   .9                          AL   .6
 KK   .9   .9                     KK   .6   .6
 LA  1.0  1.0   .9                LA   .6   .6   .6
 O6   .8   .9   .8   .9           O6   .5   .6   .5   .5
 WF  1.0   .9   .9  1.0   .9      WF   .6   .6   .5   .6   .6
 WZ   .8   .9   .7   .8  1.0   .9 WZ   .5   .6   .5   .5   .6   .6
Projected baseline lengths (km):
       FV    AL    KK    LA    O6    WF
```

```
  AL  4726.
  KK  5409.  4728.
  LA   609.  4158.  5200.
  O6  7941.  6066.  9793.  7634.
  WF  3135.  5040.  7676.  3044.  5601.
  WZ  8418.  6857. 10357.  8162.   920.  5998.
```

Note that there is no observation epoch associated with the **vscan** command, and so the full baseline length is used in the calculation of scan length and SNR. Thus the **vscan** displays give the worst-case SNR, and most actual observations will have better SNRs because the projected baseline at the time of the observation will be used in the calculations. See the discussion and equations for scan lengths and SNR starting on page SKED-106. When a new scan is scheduled or when an existing scan is checked, the calculation of projected baseline takes into account the current time and the observed flux is then calculated using the projected (foreshortened) baseline.

The display which lists scan lengths and SNRs for *all* sources suppresses error messages and automatically drops stations from the display if they have inadequate SNR. The information in the all-source display is similar to having the parameter **snr** set to **auto**.

A portion of the display from the command **vscan _ dakl**:

```
 Variable scan info for WB (CDPSXWB4)
Source       Durations           SNRs for X-band
              FV   AL   KK   LA  F-A  F-K  F-L  A-K  A-L  K-L
 1 0048-097   75   60   75   75   35   30   51   35   36   31
 2 0059+581   60   60   60   60   84   62  114   86   85   63
 3 0119+041  105   60  105   95   34   30   91   34   39   30
 4 0229+131  105   60  105   95   35   30   91   35   39   30
 5 0454-234   60   60   60   60   44   32   68   45   47   33
 6 0458-020   60   60   60   60   81   62  114   81   84   62
 7 0528+134   60   60   60   60  114   83  178  115  121   86
......
40 2145+067   60   60   60   60  234  171  364  234  247  175
41 2234+282  285  285   -1   70   30   -1   44   -1   31   -1
42 2255-282   60   60   60   60   56   42   78   56   57   43
Source       Durations           SNRs for S-band
              FV   AL   KK   LA  F-A  F-K  F-L  A-K  A-L  K-L
 1 0048-097   75   60   75   75   23   27   38   23   24   27
 2 0059+581   60   60   60   60   74   73  114   74   75   74
 3 0119+041  105   60  105   95   43   56   86   42   44   54
 4 0229+131  105   60  105   95   43   54   93   42   45   53
 5 0454-234   60   60   60   60   70   68  114   69   72   69
 6 0458-020   60   60   60   60   87   87  137   85   89   88
 7 0528+134   60   60   60   60   60   55  119   59   65   57
```

```
.....
40 2145+067   60   60   60   60   71   72  167   70   73   72
41 2234+282  285  285   -1   70  123   -1  105   -1   64   -1
42 2255-282   60   60   60   60   30   40   68   41   44   33
```

A `-1` in the display means that this source cannot meet the minimum SNR requirements for the station and its baselines. If this source were scheduled interactively, you would be asked if you want to schedule it anyway. In auto-select mode, the station would be automatically dropped from the observation. More information about the achieved SNR can be obtained with the command **`vscan 41 fv-al-kk-la`**:

```
SNR of  25 is less than minimum  30 required for KK-LA at X-band
 Variable scan info for 2234+282
 Station:     FV   AL   KK   LA
 Duration:   285  285  372  520
 SNR by baseline:
          X-band               S-band
     FV  AL  KK           FV  AL  KK
 AL  30              AL 123
 KK  30  67          KK 117 122
 LA  88  62  25      LA 211 128 137
 Observed flux by baseline:
          X-band                    S-band
       FV   AL   KK             FV   AL   KK
  AL   .4                 AL  1.4
  KK   .5   .8            KK  1.3  1.4
  LA   .9   .8   .3       LA  1.7  1.5  1.3
 Projected baseline lengths (km):
        FV    AL    KK
  AL  4726.
  KK  5409.  4728.
  LA   609.  4158.  5200.
```

In the above example, the source is too weak to be observed on the `KK-LA` baseline only. In automatic mode the weakest station, `Kk`, is dropped, thus eliminating observations on all three of its baselines.

You can use this command to plan a strategy for making the schedule. You can try different SNRs and different values for the parameters that specify minimum scan lengths and the modular unit for scan lengths.

If the required scan length for a given SNR will be greater than the maximum scan length, the actual SNR will be less than requested. The **margin** option on the **snr** command can be used to fine tune the required SNRs.

wc, wr

Syntax: **wc** *new-file-name*
wr [*existing-file-name*]

Similar to the **ec** and **er** commands, the **wc** command (**w**rite, **c**reate) creates a new file with the name supplied, and the **wr** command (**w**rite, **r**eplace) replaces the file being edited (or the file named) with the edited version just produced in this sked session. The difference in the **ec**, **er**, and **wc**, **wr** commands is that you end the edit session with the former commands whereas you return to where you were in the scheduling with the latter.

With the **wr** command, you are asked to confirm replacement of the file. With both commands, valid access to the file is checked.

Before saving, sked reads through the schedule and checks that all of the sources and stations you have scheduled are currently selected. If not, an error message is printed and you will be asked whether you wish to continue anyway, saving the schedule file as is.

For the **wr** command, the current values for the $EXPER and $PARAM sections are always written into the output file. Other sections are re-written from sked's scratch files only if a change has been made, that is, selection has been done or new observations have been added. Unchanged sections are copied in their entirety from the original file.

If you do a **wc** command, the newly-created filename becomes current and further saves can be accomplished with **wr** or **er**.

sked writes out the $EXPER, $PARAM, and unchanged file sections first, followed by the sections that have been modified in this scheduling session. Thus the order of the sections within the schedule file may change depending on what changes you make in your schedule.

The path specified in the control file, if any, is pre-pended to the file name specified with this command.

whatsup

Syntax: **whatsup** [*subnet* [**full** * **min** * **no** [*time*]]]

This command displays a list of sources which are up and available for the next scan. The telescope pointing position and slewing time required are displayed for each station in the *subnet* specified, or for the stations in the default subnet if nothing is specified. The pointing positions are listed as of the end of the slewing time, *i.e.* when the new scan could begin. The tape and time status at the end of the current scan at each station is also displayed. The program also looks ahead by the amount indicated in the parameter **lookahead** and will print a message if any source will rise or set within this amount of time in the future. Lookahead is done in steps of 1/20th of **lookahead** parameter. A source is displayed if it is visible at more than one station in the subnet, or if it is visible at one station and will rise at one or more stations during the lookahead time.

The standard display consists of azimuth, elevation, and slewing time for each station. This is also the **min** display. The **full** display includes hour angle as well. The **no** option will not make any display; this is useful in auto-select mode if you are only interested in the chart of the "best" observations.

The parameter **width** determines how many stations can fit across the screen or a page. The fixed part of the display is 25 characters and each station needs 16 characters for **full** and 12 characters for **min**. If you have 10 stations, a **width** of 145 will display all 10 in landscape orientation on a printed page. An example display is shown below.

```
WHATSUP display for frequency code WB (CDPSXWB4)

                              FV           AL           KK           LA
 End of current obs:        20:01:35     19:58:10     19:58:55     19:58:10
                             MR15840      1F03600      7F02812      JF09337
 Remaining:               684s=15840f  212s=05220f  247s=06008f  349s=08303f
# Source   Scan Last Obs  Az  El  Sl   Az  El  Sl   Az  El  Sl   Az  El  Sl
2 0059+581  196 00:20 26| 330 15 1.5 | 291 58 1.5 | 327 36 1.2 | 328 20 1.7
3 0119+041  196 01:09 21|            | 249 14 2.3 | 259 36 1.3 |
4 0229+131  196 00:10 23| 282  5 1.9 | 235 29 1.9 | 261 56 1.4 | 280  9 1.6
                        | set in  6  |            |            | set in  25
5 0454-234  196 00:49 11| 231 14 1.4 |            | 178 44  .7 | 228 13 1.5
6 0458-020  196 00:16 18| 248 29 1.5 | 190 23 1.4 | 174 66  .6 | 243 30  .9
```

```
 7 0528+134  196 00:31 22| 259 44 1.7 | 183 39 1.1 | 130 77  .4 | 251 45  .8
 9 0552+398  196 00:42 22| 297 56 1.9 | 173 65 1.0 |  34 68  .6 | 289 60 1.2
10 0727-115  196 00:57 13| 203 45 1.3 |            | 127 38  .2 | 197 41  .5
11 0735+178  196         | 230 71 2.2 | 143 39  .4 |  89 50  .2 | 212 69  .4
12 0804+499  196 01:06 21| 346 70 2.1 | 110 65  .6 |  42 43  .5 | 349 76 1.9
13 0820+560  196         | 356 65 2.0 |  95 68  .7 |  35 38  .6 | 360 70 2.0
14 0823+033  196 00:03 16| 186 62 1.9 | 134 21 *** | 102 34 *** | 179 57 ***
15 OJ287     196 00:14 18| 160 79 2.4 | 120 35  .3 |  80 33  .2 | 154 73  .5
16 0919-260  196 06:51  4| 168 32  .9 |            | 123  9  .2 | 166 26 1.0
17 4C39.25   196 01:13 19|  46 77 2.4 | 100 49  .6 |  57 30  .4 |  70 77 1.2
18 OK290     196 02:38 11| 102 72 2.2 | 102 33  .5 |  70 21  .3 | 111 68  .7
19 0955+476  196 03:13 11|  37 67 2.1 |  85 52  .7 |  47 25  .5 |  49 69 1.4
20 0954+658  196         |  14 53 1.6 |  59 64  .9 |  26 25  .7 |  18 57 1.8
21 1034-293  196 00:13  5| 152 23  .6 |            |            | 150 18 1.3
22 1044+719  196 13:08  1|  14 45 1.3 |  42 63 1.0 |  20 21  .7 |  16 50 1.8
23 1053+815  196 07:59  6|   6 38 1.1 |  21 65 1.1 |   9 22  .8 |   7 42 1.9
25 1128+385  196 00:47 13|  66 54 1.6 |  73 35  .9 |  51  6  .5 |  72 53 1.2
26 1219+044  196 00:37 20| 105 31  .8 |            |            | 105 27 1.0
27 1308+326  196 00:06 24|  69 33  .9 |  56 20 1.2 |            |  71 32 1.2
28 1334-127  196 00:00 14| 109  6 *** |            |            |rise in  22
29 1357+769  196 01:21 19|  15 32 1.0 |  20 56 1.2 |   9 12  .8 |  16 36 1.8
31 1606+106  196 01:02 21|            |            |            |
32 1622-253  196 00:03 11|            |            |            |
33 NRAO512   196 00:17 20|            |  12 15 1.9 |            |rise in  31
34 1726+455  196 00:57  9|            |   2 21 1.8 |            |
35 1739+522  196 00:10 11|            | 360 27 1.7 |            |rise in   6
36 1741-038  196 00:28 21|            |            |            |
37 1749+096  196 04:34 18|            |            |            |
40 2145+067  196 00:31 28|            |            |            |
41 2234+282  196 01:31 18|            | 296 19 2.2 | 298  7 1.4 |
                                      |            | set in  14 |
```

On the display, the first line lists the station IDs. The second line shows the ending time of the current observation and the pass number, direction, and footage count of the tape at that station. The `Remaining` line shows how much footage remains on this pass of the tape and how many seconds of recording time this footage corresponds to.

`Scan` is the scan length for this source, which will be used only if parameter **`vscan`** is **`n`**. `Last` is the time since this source was last observed, on any subnet, in hours and minutes. The current time is taken as the time of the first station displayed by this command. `Obs` is the number of scans so far in the schedule on this source.

`Az` and `El` give the azimuth and elevation of the source at the time the new observation could begin at that station, in integer degrees. `Sl` is the time in decimal minutes that the antenna requires to slew

from the current source to the listed source. The current source being observed at each site is indicated by ** in place of the slewing time.

If parameter **snr** is **auto**, then information is not displayed for stations for which the source cannot be observed due to low SNR. Because the SNR calculations depend on the actual subnet used to schedule, the display may not be exactly consistent with the results you will see in scheduling a source if you specify a subnet. **whatsup** considers that if the SNR is too low on any of the baselines to a station, it will drop that station from the display.

The *time* field specifies the ending time of the automatic schedule generation. *time* is in standard sked time format. sked will automatically select scans to fill up the schedule from the time of the current scan, stopping when *time* is reached. You can generate one new automatically selected subconfiguration if you use the period, **.**, which means the current time. If no *time* is given then only a display is shown and no observations are added to the schedule.

Selection of subconfigurations for evaluation is performed during the execution of the **whatsup** command. Refer to the discussion starting on page SKED-115. The logic flow for automatic selection is described starting on page SKED-120.

If the command **subcon on** was issued, then each subconfiguration that is evaluated is also displayed on the screen. The display is the full schedule entry as it would appear in the $SKED section of the schedule file.

If the normal equations have been set up with the **op go** command or if the sky coverage option is turned on, then a chart of 15 highest ranked subconfigurations are displayed. Ranking is done according to how much each new subconfiguration would improve the schedule. For each optimized parameter the relative improvement in the matrix of normal equations is displayed. Refer to page SKED-116 for the equations. The criterion for ranking the subconfigurations is the sum of these values.

The sample display below shows a portion (part of the first row) of the subconfiguration chart from the **whatsup** command.

```
STAT4: Total number of tested subconfigurations:  19

STAT4: Number of subconfigurations tested for minor options :   6

================================================================================
========
Source   Dur: |1308+326    60 |0229+131    60 |0919-260    60 |0229+131    60
|0229+131    60
```

```
Stations:     |DWA-LW         |A-K-           |D-L-           |A-K-           |A-K-
Start time:   |94194210005    |94194210035    |94194205950    |94194210035
|94194210035
Source   Dur: |               |1104-445    60 |               |1034-293   60
|1308+326    60
Stations:     |               |D-L-           |               |D-L-           |DWLW
Start time:   |               |94194205950    |               |94194205950
|94194205950
sky coverage  |        .611   |        .491   |        .468   |        .411   |
.380
================================================================================
========
================================================================================
========
Source   Dur: |0954+658   375 |0229+131    60 |OJ287       60 |1739+522    60
|1128+385   135
Stations:     |DCA-KWLC       |A-K-           |D-A-KWL-       |DWA-LW
|DWA-KWLW
Start time:   |94194210525    |94194210035    |94194210035    |94194210010
|94194210035
Source   Dur: |               |0919-260    60 |               |               |
Stations:     |               |D-L-           |               |               |
Start time:   |               |94194205950    |               |               |
coverage      |        .329   |        .322   |       .301    |        .295   |
.293
================================================================================
========
```

In the above sample, sky coverage was optimized. For each subconfiguration, from top to bottom, the display shows the scan(s) and the improvement in the sky coverage that this subconfiguration provides. If covariance were the major optimizing criterion, then the improvement in the estimation of the optimized parameters would be displayed as a percentage.

xlist

Syntax: **xlist** [**on** * **off** * [**feet** * **azel** | **ha** * **dur** * **snr** * **flux** * **max**]]

This command controls the type of extended listing which appears for the **list**, **next**, **current**, and **previous** commands. When sked starts, the default option for **xlist** is **dur**, *i.e.* durations are displayed.

With the **off** option, the scan information as it appears in the schedule file is displayed.

With the **on** option, all possible information is displayed. In this case, the display will accommodate only 5 stations. If you have more than 5 stations and want the full display, you will have to list them with separate commands using subnets.

The other options display different types of information about each scan and may be used in any combination.

feet	will display the tape footage counters at all stations.
azel	displays elevation and azimuth.
ha	displays hour angle, elevation, and azimuth.
dur	lists scan durations by station.
snr	lists calculated SNRs by baseline.
flux	lists observed flux by baseline.
max	produces a listing with all information, identical to **xlist on**.

If the **xlist** command is issued with no arguments, it simply toggles between **on** and **off**, with an accompanying message indicating its new setting.

xnew

Syntax: **xnew** [**on** * **off** * [**snr** * **sefd** * **flux** * **base**]]

This command controls the type of extended listing which appears for the **/**, or new scan, command. When **sked** starts, the default option for **xnew** is **on**, i.e. all the matrix displays will be listed when you schedule a new scan.

With the **off** option, information is displayed about the new scan start time, slewing times from the previous source, station durations, and footages.

With the **on** option, in addition to the scan information there are four matrix displays that will appear if you are scheduling a scan with the parameter **vscan** set to **y**. The four matrices display the SNR achieved on each baseline in the new scan, the projected baseline length for each station pair, the observed flux on each baseline, and the effective SEFD at the station and the source elevation.

The other options display different types of information about each scan and may be used in any combination. You can specify some or all of the options in one command.

base	displays the matrix with projected baseline lengths for this scan.
snr	lists calculated SNRs by baseline.
flux	lists observed flux by baseline.
sefd	lists the effective SEFDs and the source elevation for this scan.

If the **xnew** command is issued with no arguments, it simply toggles between **on** and **off**, with an accompanying message indicating its new setting.

4.0 Implementation

This section describes the algorithms, definitions, and equations used by `sked` for critical processes and calculations. References to subsections are made throughout the command descriptions.

4.1 Subnetting

Immediately after station selection, a default subnet is initialized to hold all of the stations just selected. Thereafter, `sked` attempts to schedule each station in the default subnet to participate in each observation if no particular subnet is specified. The stations in the default subnet may be changed at any time via the **`parameters subnet`** command.

You can schedule an observation in which fewer than the total number of stations in the default subnet participate. This is accomplished either by specifying a subnet in the new observation command, which overrides the default subnet for that observation, or letting `sked` eliminate stations automatically when it finds that a source is not up at a particular station or that a source has insufficient SNR at a station.

When the observation is scheduled, the slewing times for only the subnet stations are taken into account in calculating the start time and the tape footage count is advanced for the subnet stations only. Subsequent observations have slewing times and tape footage calculated from the last observation in which a station participated. Observations are written into the schedule such that all observations appear in increasing time order.

If the **`synchronize`** parameter is set to **`on`**, then any observation which is scheduled will be recorded at the same physical location on tape (*i.e.* identical direction and footage count) at all participating stations. The time required to align the tapes before a new observation begins is taken into account by `sked`. The SNAP commands which do the tape positioning in the field are inserted into the schedule automatically by `drudg`. Both `drudg` and `sked` use the same algorithm to compute tape spin time.

If **`synchronize`** is **`off`** (default setting), then when a new observation is scheduled it will be recorded on the next available section of tape at each participating station. This most likely will not be

the same physical location on all tapes. This method will, in general, use significantly fewer tapes than the method which synchronizes tapes. However, tape changes will be distributed throughout the schedule and this tends to reduce the total number of observations possible in a day.

4.2 Cable Wrap Algorithms

Cable wrap for az-el telescopes is handled by `sked` in the following manner. The entire cable is viewed as a single continuous wrap which begins at a certain (positive) azimuth and proceeds clockwise through ever-increasing azimuths (values may be greater than 360 degrees) to the end of the cable. Negative values for azimuth cable limits are not understood by SKED. The so-called "neutral point" is located halfway between the azimuth travel limits of the telescope. The two parts of the cable, one on either side of the neutral point, are designated by the letters "C" (clockwise) and "W" (counter-clockwise), where clockwise and counter-clockwise are the direction of travel from the neutral point looking down on the antenna.

The azimuth limits displayed by the **`station list`** command show the full range for the az-el telescopes. In listings, azimuths are displayed in the range 0 to 360 degrees. If a telescope azimuth falls in a non-unique portion of the cable, it is tagged by a letter indicating on which wrap (C or W) the telescope is positioned. The letters "W" and "C" are used to request that an observation be scheduled such that the telescope moves to that wrap for the observation. (Note, however, that such requests are not implemented in SNAP files, and must be handled manually by the operator.)

4.3 Definition of a Valid Scan

There are several criteria which must be met in order for a scan to be valid. The following things are checked when a new observation is scheduled and during **`check`**, **`autoshift`**, or **`tagalong`**.

- The new source must be within antenna limits within one hour after the end of the previous scan. This allows for the case when the source has not yet risen at the beginning of the slew, but may still be up for the start of the next scan.

- The source must be within antenna limits at the start of the scan and at the end of the scan.

- The tape usage must be valid: no formatter mode switching in the middle of a tape pass, and no scan longer than the length of a tape.

- There must be sufficient time allowed between scans for slewing, tape spinning, tape changes, and set-up.

- At antennas with az-el mounts, the continuity of the scan is checked to ensure that it begins and ends on the same cable wrap.

- At antennas with az-el mounts, the slew to the new source is checked for convergence. This problem could arise if the source is on one portion of the cable wrap at the beginning of the slew, but by the end of the slew, it has moved onto the other portion of the wrap.

- When automatic scan length calculations are enabled, the source strength and antenna sensitivity must be sufficient to achieve the specified minimum SNR on all baselines to the antenna.

4.4 Catalog Access

4.4.1 sked Selection

The following procedures are used by `sked` for accessing and selecting catalog information:

- `sked` initially creates scratch files and writes into them any information it finds in the schedule file sections `$SOURCES`, `$STATIONS`, `$HEAD`, `$FLUX`, and `$CODES`. Any comments within these sections are preserved in the scratch files.

- The **`select`** option on the **`source`**, **`station`**, and **`frequency`** commands accesses catalog files. All entries in the catalog are displayed by name, and you select the ones you want for your schedule. When source, station, or frequency selection is done interactively, `sked` puts the names of the entries into a list of "selected entries". During the process of selection you add to or remove from this list. For sources, the common names are used for selection; for stations, antenna names; for frequency codes, the name of the observing mode.

- When you exit from selection, `sked` will read the information it requires from all relevant catalog files and create the appropriate format for the `sked` file section(s). New scratch file(s) are written with the new information you have just selected.

- Information from the catalog files is always retrieved unless you specify the **`OR`** option (only available for sources) which will retain (some of) the information from your original schedule file.

This is not recommended because you should normally get fresh data from the catalogs for scheduling.

- When the **er** or **wr** command is executed, sked copies the scratch files directly into the schedule file if selection has been done. If selection has not been done for any of the three types of information, then the corresponding section of the original file is copied in its entirety into the output file. This latter procedure preserves any comments which might have been added to the schedule file.

4.4.2 Access Logic

The following detailed steps are followed by **sked** in collecting catalog information:

1. Sources
- original scan lengths and fluxes are saved by source name
- names from the source.cat file, or specified file, are read in and checked for duplicates
- grades from flux.cat.comments file are read in
- source common names and grades are displayed
- user selects sources
- for each selected name, get position and epoch from the catalog file
- write/re-write the SKXnnnnn scratch file ($SOURCES section)
- restore scan lengths and fluxes for same-named sources
- set scan lengths to default for sources not in the save list

2. Stations
- all user-specified values and parameters are saved by station name
- names and 1-letter codes from antenna.cat are displayed
- user selects stations, optionally changing the 1-letter station ID code
- for each selected name:
  get antenna information from antenna.cat
  if the 1-letter ID code for antenna is the same as another, change subsequent ids
  get positions from matching position code in position.cat
  get information from matching antenna name in equip.cat
  get horizon or coordinate mask from matching antenna name in mask.cat
- write/re-write the SKYnnnnn scratch file ($STATIONS section)
- restore user-specified values and parameters for same-named stations
- set defaults for elevation limit, SNR, tape motion, early start, and optimization parameters
  for stations not in the save list

3. Frequencies
- stations must be selected first
- names from `modes.cat` are displayed
- user selects mode(s)
- for each selected mode:
  get RF frequencies and channel references from `freq.cat`
  get receiver setups from `rx.cat` and LO and channel assignments from `loif.cat`
  get recording mode information from `rec.cat`
  get head positions from `hdpos.cat` and track assignments from `tracks.cat`
  write/re-write the `SKZnnnnn` scratch file (`$CODES` section)
  write/re-write the `SKHnnnnn` scratch file (`$HEAD` section)

4. Fluxes
- sources must have been selected first
- fluxes are retrieved from `flux.cat.nnnn` for each source name and the selected frequency bands

4.4.3 Selection Error Conditions

1. Sources: If no flux is available for a given source, you will not be able to use the automatic scan length calculation features.

2. Stations: If no position is found for an antenna, or if no slewing rates are present, `sked` cannot continue and resets the stations to "none selected". If no equipment entry is found for an antenna, `sked` uses the default values for tape length and number of passes so that you can continue scheduling. These default values are set in the `sked` parameter file. If no SEFD values are found, you will not be able to use the automatic scan length calculation features.

If a horizon mask is found but there is no matching code from the `A` line, `sked` checks for a matching code from the `P` line. This check is done so that information in old schedules without mask codes on the `A` lines will be read properly.

3. Frequencies: If no LO information is found for a station, `sked` will continue with a warning message. The consistency of the number of tracks, subpasses, and channels is checked thoroughly and any problems are reported.

4.5 SNR Calculations

4.5.1 Basic Equations

Equations to calculate required durations and expected SNRs are as follows.

$$F \text{ ' } correlated\ (observed)\ flux\ density$$

$$SNR \text{ ' } \frac{?}{s}$$

$$? \text{ ' } \frac{F}{(SEFD_1 \times SEFD_2)^{1/2}}$$

$$s \text{ ' } \frac{1.75}{(bits)^{1/2}}$$

$$bits \text{ ' } rate \times \#channels \times duration$$

$$scanlength \text{ ' } \left(\frac{1.75 \times SNR}{F}\right)^2 \times \left(\frac{SEFD_1 \times SEFD_2}{rate \times \#channels}\right)$$

Individual station scan lengths (durations) and baseline SNRs achieved are calculated as follows. All calculations are done for both bands (S and X). Details of the program logic are found in the next section.

- For each baseline, calculate number of seconds required to achieve the required SNR, using the observed flux density on that baseline, SEFD for each antenna, number of channels, bandwidth, and SNR.

- For each station, find the longest duration, for both bands, of all baselines the station participates in. This is the duration assigned to the station.

- For each baseline (station pair), use the shortest duration of the two stations to calculate the actual SNR achieved.

Flux density applicable to the observed flux for the baseline length is used to calculate the scan durations by baseline. Refer to page SKED-113 for the equations used to calculated observed flux, *F*. If the source is not strong enough on any of the baselines the affected station is treated similar to the case where a source is not above the horizon at a station.

SEFDs are adjusted for the elevation of the source at each station. See page SKED-? for the equations.

If the calculated SNR is lower than the minimum required on any of the subnet baselines to a station, the station is dropped automatically if parameter **`snr`** is set to **`auto`**. If **`snr`** is set to **`manual`**, you are asked each time if you want to schedule it anyway.

4.5.2 Calculating Scan Lengths

1. Check that SEFDs are present for all stations.
2. Check that flux density is present for this source.
3. For each band (*e.g.* S, X)
   For each baseline
      Calculate scan length required on this baseline

$$scan(\text{sec}) \text{ ' } \left(\frac{1.75 \times SNR_{\min}}{flux} \right)^2 \times \left(\frac{SEFD_1 \times SEFD_2}{2 \times bandw \times nfreq} \right) \text{ \% } CORSYNCH$$

      bandw = video converter bandwidth (Hz)
      flux = observed flux for this baseline (Jy)
      nfreq = number of channels in this band
      $SNR_{\min}$ = minimum SNR specified in **`snr`** command for this baseline
      CORSYNCH = value of parameter **`corsynch`** (sec)
      SEFD = station SEFDs as they appear in the **`station list`** command (Jy), adjusted for elevation

      If flux is 0 on this length baseline, then *scan*=-1
   End baseline loop
   End band loop
4. Select scan length for a station by choosing the longest of the scan lengths calculated for all baselines with this station.

5. Select the longer of the scan lengths for the two bands.
6. Round the station scan length up to the next higher modular time unit.
7. Select the shorter of the calculated scan length and the maximum scan length (depends on tape length and recording speed).
8. Calculate actual SNRs achieved on each baseline, using the actual station scan lengths.

4.5.3 Calculating Predicted SNR

For each baseline

Use the smaller of the scan lengths at the two stations of this baseline. This is the amount of data that will be correlated.

For each band

$$actualSNR \text{ ' } \left(\frac{2 \times bandw \times nfreq}{SEFD_1 \times SEFD_2} \right)^{½} \times \left(\frac{flux}{1.75} \right) \times scan^{½}$$

If $actualSNR < (SNR_{min}$ for this baseline - margin) then increment number of bad SNRs for this station

End band loop

End baseline loop

4.5.4 Checking SNRs

1. Calculate durations for each remaining station
2. For each station

   If scan length < 0 this means the flux was 0 on all baselines to this station. Mark this station as **?**no flux".

   End station loop
3. For each station

   Check weakest (*i.e.* largest SEFD) station first. If number of bad SNRs > 0 this means minimum SNR could not be achieved on some baselines. Mark this station as **?**low SNR."

   End station loop
4. Eliminate **?**no flux" and **?**low SNR" stations from list of stations and go to 1.

4.6 Tape Motion and Tape Usage

`sked` supports three types of tape motion, known as "start&stop", "continuous", and "adaptive". Use the **`tape`** command to specify the type for each station. The type will determine whether the tape is started at the beginning of each scan and stopped at the end, or whether it is run more or less continuously even during tape slewing periods. `sked` calculates how much tape footage is used for a scan using the tape speed, which depends on the sample rate, fan-out factor, recording format, and bit density. The Mark IIIA correlators support only start&stop tape motion, the VLBA correlator supports all types.

4.6.1 Tape Speed

Tape speed is calculated with the following equation:

$$speed = \text{ohfac} \times r / (\text{bitdens} \times n)$$

where

ohfac = 9/8 for Mark III/IV data-replacement (DR) format
= 9.072/8 for VLBA non-data-replacement (NDR) format
n = fanout factor, either 1, 2, or 4
r = sample rate in bits/sec
bitdens = bit density in bpi
33333 for Mark III/IV data-replacement format (thick tape)
34020 for VLBA non-data-replacement format (thick tape)
56250 for Mark III/IV data-replacement format (thin tape)
56700 for VLBA non-data-replacement format (thin tape)
Note that bit density depends on the recording mode, not on the station equipment, but remember that Mark IV equipment can only record in data-replacement modes while VLBA equipment can do either mode. The high density modes *require* thin tape to be used.

4.6.2 Start&stop Motion

The default type of tape motion is called "start&stop". At the beginning of each scan the tape is started moving and at the end of the scan it is stopped. If an early tape start is specified with the **`early`** command, the tape is started that much time before the scan start time. The footage used up during the early start time is included in the calculation of the footage used for that scan.

If there is not enough tape remaining in the same direction as the previous scan, `sked` will put in enough time for the tape to be fast forwarded or rewound to the end or start of the next pass. Then the

scan will be set to record in the new direction. This extra time is called "spin" time and is displayed when a new observation is scheduled.

If the parameter flag for parity checks is **Y**, then `sked` will add enough time for a parity check after the first scan recorded on each pass. This is the only scan for which the time is allowed.

4.6.3 Continuous Motion

When you specify continuous tape motion, `sked` starts the tape at the beginning of each pass and runs it continuously until the end of the pass. The tape is started only at the beginning of a scan. This means that the idle time between the end of one pass and the start of another is arbitrary. This type of tape motion will maximize the possible SNR you can achieve in a schedule, but it also maximizes the tape usage. The total amount of time on-source is used to calculate SNRs, not just the minimum time required to achieve the target SNRs.

If the parameter flag for parity checks is **Y**, then `sked` will add enough time for the parity check and setup procedures after the tape has reached the end of the pass.

If there is not enough tape remaining in the pass for the scan to finish, `sked` will add enough time for the tape to roll to the end of the pass, do the parity check and setup procedures if required, and set up for the new direction. Then the new scan can start. The general algorithm used for determining the start of the next scan is:

if (`source` + slew + `cal` + duration) **speed* > remaining feet on this pass then
    roll tape to the end, do procedures, and start the new scan

If you are scheduling manually, you would want to avoid scheduling scans that would generate long running times to the end of the tape. Instead, try to schedule a scan that will fit into the remaining tape. If you are scheduling automatically, the much later start time for this scan would give it a lower priority in the list of possible scans that may be selected.

4.6.4 Adaptive Motion

With adaptive tape motion the tapes are run continuously but they are stopped if more than the specified "gap" time would be wasted between scans. The general algorithm that `sked` uses for adaptive motion is:

if (`source` + slew + `cal-early`) > *gap* then
    stop the tape between scans

if (`source` + slew + `cal` + duration) * *speed* > (remaining feet on this pass) then
  if (duration**speed*) < (remaining feet on this pass) then
    stop the tape between scans
  else
    roll tape to the end, do procedures, and start the new scan

The cue for `drudg` to know whether to stop the tape is that the calculated footage for the end of one scan is equal to the starting footage for the next scan, including any early tape start.

4.7 New Scan

When a new scan is requested, `sked` takes the following steps and makes these calculations to determine if the scan is valid.

1. Calculate slewing time to the new source.
   If source will rise within the **`lookahead`** time, then set slewing time equal to the time remaining until the source rises, and mark it as rising.
   For each station
   If the new source is not up at the end of the previous observation then
   If **`vis`** is **`sub`** then drop this station
   IF **`vis`** is **`all`** then quit
   If source is marked as rising, ask if user wants to delay start of observation until source rises
   End station loop
2. Calculate scan lengths, calculate predicted SNRs, check SNRs against minimum required.
   For each station
   If station had any baselines with **?**low SNR" or **?**no flux" then
   If **`snr`** is **`auto`** then drop this station
   If **`snr`** is **`man`** then ask if the user wants to schedule it anyway
   End station loop
3. Determine best tape footage at each station, including tape spin time.
4. Calculate start time of the observation, if none is specified. See page SKED-20 for how the start time is calculated.
5. If the source is too close to the sun at the start time then quit.
6. For each station
   Calculate source position at the start and end of the new observation.
   If the source is not up at the start or if the source is not up at the end then
   If **`vis`** is **`sub`** then eliminate this station

If **vis** is **all** then quit
End station loop
7. Display observation parameters
If **confirm** is **yes** then ask if OK before adding observation.
If **confirm** is **no** then add the observation.

4.8 Multiple Rises/Sets

It may happen that a source "rises" or "sets" more than once at a station. An example of this phenomenon happens at Fairbanks where there is a hill just at the maximum elevation of some low declination sources. The source rises to the east of the hill, goes behind the hill as it transits, reappears on the west side of the hill, then sets. Another example occurs when a source passes directly overhead at a station with an azimuth/elevation mount. The source will appear to "set" during the time it transits the keyhole at zenith.

In such cases, the **sitevis** display will show only the initial rise and first "setting" of the source. This is due to the algorithm used for mutual visibility displays. A different algorithm is used for the **whatsup** display and the new scan calculations *are always correct*. The source's position for a new scan is checked at the current time and at the end of the proposed observation. If the scan is possible, it will be displayed by **whatsup** and scheduled if requested. sked will not let you schedule an impossible observation.

There is one case for which sked will *not* do the right thing. This is the case when the scan happens to begin before the source "sets" into the obstruction or keyhole and ends after the source has "risen" out of the obstruction or keyhole. Since only the beginning and end of the scan are checked, sked would think this is a valid scan.

4.9 Source Structure Models

Source structure models are used in sked to calculate the predicted observed flux on each baseline of a scan. The current implementation uses elliptical gaussian models. Parameters for the source models are found in the $FLUX section of the schedule file.

The effect of having sources with extended structure is that they are partially resolved on long baselines, thus reducing the observed flux. The baseline length that is appropriate is the projected baseline. For example, when a source is rising at Mojave, the baseline to Westford is foreshortened

and therefore generally more of the source's flux would be observed than when the source is more nearly overhead at both stations.

The equations below are used in **sked** to compute the observed flux density for a given scan. All angles are in radians, *uv* components are in wavelengths, and flux density is in Jy. The observed flux for all components is added to obtain the total observed flux for a given scan. As of this release of SKED, offsets of components from a centroid is NOT implemented. Separate calculations are done for X- and S-band.

The observed flux for one model component is calculated from the following equation:

$$obsflux \quad ' \quad flux \times \exp \frac{\&(p \ ? \ l)^2}{4 \ \ln 2}$$

where

obsflux = predicted flux density that will be seen for this observation, for this component

flux = total flux density of the component

? = size of the major axis of the component

l = effective baseline length, taking into account the baseline projection and the position angle of the component. For a circular source, *l* is the *projected baseline*.

$$l \ ' \ (v\cos pa \ \% \ u\sin pa)^2 \ \% \ R^2(u\cos pa \ \& \ v\sin pa)^2$$

$$u \ ' \ b_x \sin GHA \ \% \ b_y \cos GHA$$

$$v \ ' \ b_z \ \% \ \mathrm{sind}(\&b_x \cos GHA \ \% \ b_y \sin GHA)$$

where

b_x, b_y, b_z = components of the baseline

R = axial ratio of the component (1.0 for circular)

pa = position angle of the component major axis with respect to the origin

GHA = Greenwich hour angle of the source

d = source declination

The observed fluxes by baseline are displayed in matrix form when a new scan is scheduled interactively.

The projected baselines that are displayed in matrix form when a new scan is scheduled interactively are calculated from the *u* and *v* components:

$$projected\ \ baseline\ '\ \sqrt{u^2\ \%\ v^2}$$

The calculations of observed flux for the **vscan** command are slightly different because there is no epoch associated with the calculations. The equations are identical except for the calculation of *u* and *v*. For the **vscan** command:

$$u\ '\ \sqrt{b_x^2\ \%\ b_y^2}$$

$$v\ '\ b_z \cos d$$

$$projected\ baseline\ '\ \sqrt{b_x^2\ \%\ b_y^2\ \%\ b_z^2}$$

4.10 Automatic Scan Selection Algorithms

4.10.1 Subconfiguration Selection

sked considers a restricted subset of possible configurations for automatic selection. The main reason for limiting the number of observations is that the total number of possible configurations is far too large to consider absolutely every one. Also many of the possible configurations would not be likely to be selected due to the small number of VLBI observations they would contribute to the schedule. The restrictions are designed to simply consider only those configurations which are most likely to be selected.

A separate subroutine is used depending on how many stations are in the network. Because of the approach of deliberately limiting the number of configurations considered, it has not been possible to design a completely general single subroutine. As of the date of this document, subroutines exist to support up to an 8 station network.

sked determines the possible configurations using the **whatsup** calculations for which sources are "up" at the current time. A matrix is filled in which holds a flag indicating which sources are visible at which stations. sked then selects for testing a subconfiguration which consists of one or more scans that

could be observed using the available sources and stations at the current schedule time. This approach simulates what a human scheduler might do. For example, with a 6-station network, the scheduler might select a source that the entire network could observe and then schedule a single scan resulting in 15 observations. Or, the scheduler might select 3 stations to observe one source and the remaining 3 stations to observe another source; this results in 2 scans and 6 observations. Each set of scans that could be observed at a given point in the schedule is called a subconfiguration.

The table below shows which groupings of scans sked considers in selecting a subconfiguration. The ?subconfigurations considered" column lists the number of stations in each scan of the subconfiguration. Subconfigurations are separated by commas. Groups of numbers in parentheses are the numbers of stations in each scan of configurations with multiple scans. The ?number of total observations" column lists the corresponding number of observations which result from each of the subconfigurations.

Note in the table that certain subconfigurations, e.g. (2,2,2,2) in the 8 station network, are not considered. This is because the resulting subconfiguration would yield too few observations relative to the other possibilities for the network.

sked as usual keeps track of the status of each station with respect to the time of its most recent observation, pointing position, and tape usage. As each scan is tested, the full sked calculations for start time are made, including slewing, early start, tape spin, and SNR calculation. Any scan that is impossible for any reason is eliminated from consideration.

Subconfiguration Selection

Number of stations in network	Number of stations in subconfigurations considered	Number of total observations
2	2	1
3	3, 2	3, 1
4	4, 3, (2,2)	6, 3, 2
5	5, 4, (3,2), (2,2), (2,3)	10, 6, 4, 2, 4
6	6, 5, (4,2), (3,3), (2,4), (2,2,2), (3,2), (2,3)	15, 10, 7, 6, 7, 3, 4, 4,
7	7, 6, (5,2), (4,3), (2,2,3), (2,5), (5,2), (3,4), (4,3)	21, 15, 11, 9, 5, 11, 11, 9, 9
8	8, 7, (6,2), (5,3), (5,2), (4,4), (4,2,2), (3,5), (3,4),	28, 21, 16, 13, 11, 12, 8, 13, 9,

(2,6), (2,5),(2,4,2) 16, 11, 8

4.10.2 Covariance Analysis

The many possible subconfigurations selected in the process described in the previous section are tested and ranked according to which ones most improve the covariance. The criteria for ranking are described in this section.

sked sets up the matrix of normal equations for all of the parameters to be estimated. For each observation, the partial derivatives of the parameters being estimated are calculated and then added to the matrix. Partial derivatives are weighted by the added noise value and type of weight, as specified in the **op** command.

Matrix of normal equations:	`mne`
Inverse matrix:	`imne`
Normal equation matrix with a test subconfiguration added:	`mnec`
Inverse of test matrix:	`imnec`
For each partial:	`coeff = coeff / s`
For equal weights:	s = `noise`
For SNR weights:	s = `sqrt [ noise`^{2} `+ 1/(2pbSNR)`^{2} `]`
	`b` = rms spanned bandwidth
	`SNR` = calculated SNR for this observation
Relative improvement for ith optimized parameter:	$tr_i = 1 - imnec_{ii} / imne_{ii}$
Trace, criterion for ranking subconfigurations:	$Tr = SUM\ (tr_i * wt_i)$

User-specified weight: wt_i
(the way the user specifies these weights has not yet been specified or implemented)

sked maintains the matrix of normal equations, and its inverse, for all observations thus far in the schedule. For each subconfiguration to be tested, sked adds each of the subconfiguration's observations to the matrix of normal equations, inverts the matrix, and calculates the fractional decrease (relative to the inverse matrix before adding the test observations) of each of the diagonal elements of the inverse matrix for the parameters being optimized. The subconfigurations are ranked according to the sum of these values, with the maximum sum ranking highest.

After evaluating the trace for one subconfiguration, the matrix is restored to its original state and then the next subconfiguration is tested, and so on. Up to MAX_CHART subconfigurations are retained and ranked. This number is set by default to 100. It is used at compile time and is specified in the file skparm.ftni.

4.10.3 Minor Options Evaluation

Either sky coverage or covariance is first chosen by the user as the major optimizing criterion for the automatic scan selection, by toggling the option in the upper left of the **op set** display. When a new scan is to be selected automatically by sked, all possible configurations of stations and sources are first sorted according to how each configuration improves the sky coverage or the covariance during the previous time window. Use the Last*nn*h option to set the size of this window. The number of configurations to be considered for the remaining minor options is specified by the user as a percentage of the total number available, up to a maximum of 100 configurations. Use the Best*nn*% option to specify the desired percentage. If *nn* is **0** then only the one best subconfiguration, as determined solely by coverage or covariance, will be selected. These top-ranked configurations are treated equally for the remainder of the selection process.

Note that if sky coverage is selected as the major criterion, then sked ignores the optimization parameters for covariance analysis, regardless of what is highlighted on the screen. A message to this effect is printed when you exit the selection screen. You must use the command **op go** to set up the automatic scheduling even if no covariance analysis is going to be done.

Now sked has the list of the best configurations for either sky coverage or covariance. Next the minor options are evaluated for each configuration. For each minor option for each subconfiguration sked computes a weight weight and normalizes it to the range 0 to 1. The weights for each enabled option are summed and the subconfiguration which has the highest total weight is the one selected and its scans are scheduled. The calculation of the weights for each minor option is described next.

`Max Obs`
`weight = nobs/maxobs`

`nobs` = number of observations in the subconfiguration
`maxobs = nst*(nst-1)` = number of observations possible if all stations observed the same source
`nst` = number of stations in the network

`LocalCov`
`weight = cov/maxcov`

`cov` = average over stations in the subconfiguration of the smallest spherical distance between the observations in this subconfiguration and the observations during the previous 4 hours.
`maxcov` = largest value of `cov` for all ranked subconfigurations

`Min Time`
`val =` mean observation start time / (latest mean time - earliest mean time)

The mean observation time is the average of the start time of all scans in the subconfiguration.

`RiseSet:` The configuration is given an additional weight of 1 if it contains a source that is rising or setting at any of the participating stations. The rising/setting status of a source is maintained throughout the duration of the lookahead time. A source is considered to be "rising" from the time it rises above the local horizon until that time plus the lookahead time, and similarly for setting. The minimum time between scans (`Betw`*nn*`m`) does not apply if a source is rising or setting and it is below the minimum elevation specified by `LoEl`*nn*`d`. This allows (but does not require) multiple scans to be made on a source as it rises or sets. If a minimum elevation is not specified (i.e., the value is set to zero, the default) then the minimum time between scans does apply. In this case, note that if the lookahead time is shorter than the minimum time between scans on the same source, then only one observation is possible during the "rising" or "setting" period.

4.10.4 Display of Results

The formal errors displayed with the **`results`** or **`results fe`** command are the square root of the diagonal elements of the variance/covariance matrix:

$$f.e._i = \mathrm{sqrt}\ (\ imne_{ii}\ )$$

With the command **`results covariance`**, the correlation matrix is displayed:

$imne_{ji}/sqrt[imne_{jj}*imne_{ii}]$

The command **`results correlation`** displays the full matrix of normal equations and the variance/covariance matrix:

mne_{ij} and $imne_{ij}$

4.10.5 Coverage Algorithm

The sky coverage value is calculated to obtain a value representative of the average sky coverage for the most recent `nwin` hours of the schedule. The value is calculated as the average over all stations of the minimum spherical distance between observations. During evaluation of subconfigurations the coverage is calculated as follows:

```
cov = [ SUM (min a) ] / nstn
```

`a` = spherical distance between the current observation and a previous observation at a station. All observations in the last `nwin` hours are considered.

`nstn` = number of stations in this subconfiguration

For the **`result`** command, the value of "coverage" that is display is calculated as:

```
cov = (min a) / sqrt(8/nobs)
```

`nobs` = number of observations checked for minimum value of `a`

$covs = [SUM\ cov_i] / nstn$

4.10.6 Automatic Selection Logic

The logic flow for automatic selection of scans is shown in the pseudo-code below:

For each possible subconfiguration
  For each scan in the subconfiguration
    Generate the start time and tape footages
    Calculate partials and weights
    Add the scan to the subconfiguration array

Invert the mne
Sum diagonal elements of the inverse mne for optimized parameters (`Tr`)
Calculate coverage value for this subconfiguration
If `Tr` is smaller (i.e. this subconfiguration is better) than the lowest-ranked subconfiguration, keep it and store it by rank
For each ranked subconfiguration, down to `nbest` % of the total number
Calculate normalized values for 3 minor options and coverage
Sum the normalized values
Select the subconfiguration with the highest sum
Enter selected subconfiguration's scans into the schedule

4.11 Elevation-dependent Sensitivity

`sked` calculates and applies an elevation-dependent reduction in sensitivity that is due to the atmosphere's addition to system temperature. In addition, some antennas have an elevation-dependent sensitivity due to changes in the amount of ground pickup caused by feed spillover. The formulation in `sked` accounts only for the system temperature contribution to an antenna's sensitivity and ignores actual gain effects. The dependence of sensitivity on elevation has been determined from system temperature data recorded at the stations and is applied in `sked` when you use automatic calculation of scan lengths to achieve a minimum SNR.

The program uses algorithms developed by Dave Shaffer that have terms in fractional powers of *1/sin(el)*. An adjustment is made to the zenith value of the station's SEFD when the calculations of scan length are made. The adjustment form is:

$$adj = \sum_{i=0}^{n} \frac{c_i}{(\sin el)^{y_i}}$$

where
n = number of terms, usually 1 to 3
el = elevation of the source
c_i = coefficient for the ith term
y = power of the *sin(el)* term, generally $0 < y \leq 1$

The final value of a station's SEFD is:

$$SEFD = SEFD_z \times adj$$

where $SEFD_z$ is the zenith value of the station's SEFD. Refer to the **sked's Catalogs** manual for the way the values of c_i and y are entered into the `equip.cat` catalog file. Adjusted values of SEFDs are displayed when you schedule an observation interactively.

4.12 Rise/Set Calculations

Numerous times `sked` needs to know whether a source is "up" at a given station at the current time. `sked` could simply compute the actual position of the source at that time and then test whether that position was above the station's various limits. A more efficient procedure is to calculate once and store the exact times at which a source rises and sets at each station. Then when it is needed to know whether a source is up, simply test whether the current time is between the rising and setting times. This approach reduces the total calculations in the program by 30%.

The simplicity of this approach is complicated by the station horizon mask that effectively lets a source "rise" and "set" multiple times. A source's path across the sky may go behind an obstruction after it rises, then emerge from behind the obstruction later. For example, this effect occurs for a few sources at Fairbanks and at Fort Davis where there are mountain peaks on the horizon. `sked` finds all of the risings and settings for each source and stores them all, then checks the appropriate one to decide whether a source is up. If a source rises and sets more than 4 times in a day, an error message is issued and `sked` stops. None of the source/station combinations we normally use have more than 4 rise/set values.

Another complication in this approach is that `sked` keeps time internally as UT, but sources rise and set at the same sidereal time each day. Therefore, it is necessary to store the rise and set times as sidereal times. When it is needed to know whether a source is up at a certain station, the appropriate time conversion must be made.

You will see the rise and set times being calculated the first time they are needed. Because the calculations take a noticeable length of time, the source numbers are counted off as the calculations are completed.

5.0 Installation

This section contains instructions for installing sked and drudg on your system. Please read through the entire section first to gain an understanding of the installation process. Then follow the detailed steps.

5.1 System Requirements

This distribution of sked and drudg is for installation on any of the 700 models of HP9000 machines running HPUX. The programs have been linked and tested under HPUX version 9.0x. The executables, catalogs, and miscellaneous files require about 5 Mbytes of disk space. If you install the source code, you will need about 110 Mbytes for source and object files.

sked uses several utility programs that you will want to have available if you make use of the plotting features or the sked-solve interface. The specific programs that are needed are:

pc8 Plotting program which uses pgplot. This program is a part of solve and is not distributed with sked.

pgplot Public domain plotting package. This package has been modified for use with pc8. If you have solve, then you have the right version.

HPGLS A special driver for pgplot needed by sked. If you do not have this driver, contact Frank Gomez Goddard (fgg@gemini.gsfc.nasa.gov).

sskedh A program in the analysis system that implements the interface between sked and solve. If you have a recent distribution of solve, then you should have this program. If you do not have it, contact Karen Baver at Goddard (kdb@leo.gsfc.nasa.gov).

You don't have to have X11 or pgplot to run sked. In fact, sked won't try to make the interactive displays unless you are running under X11. If you attempt to print a plot and one of the graphics programs is not available you will get an error message.

You will need to have the public domain facilities flex and bison installed on your machine for the VEX parsing routines. These interpreter/compiler facilities are required for compiling sked. If you do not have them you can find the latest versions at

```
http://hpux.csc.liv.ac.uk/
```

This site is a searchable archive of many routines that have been ported to HP-UX. Full instructions for building the libraries from source are included in each package. If you need assistance with this process, you can contact Frank Gomez at Goddard (fgg@gemini.gsfc.nasa.gov). When you are on the web page, search for flex- and bison.

5.2 Distribution Files

The distribution files for sked and drudg are available via anonymous ftp to the host gemini.gsfc.nasa.gov. When you ftp to gemini, do the following:

```
ftp> cd pub/sked/skversion          version is the release date
ftp> binary
ftp> get skedf.tar.Z
ftp> get skeds.tar.Z
ftp> ascii
ftp> get skedinstall
ftp> quit
```

You don't need to retrieve the catalog files separately via ftp because they are included in the compressed distribution files. The files that you just got are:

skedf.tar.Z — This file contains all the files, except source code, required to install sked and drudg. It includes executables, catalogs, and miscellaneous files.

skeds.tar.Z — This file contains the source code and makefiles for sked, drudg, and their utility routines.

`skedinstall` This file is a script to install the programs. It uncompresses the tar files, extracts the files, and copies them to user-specified directories.

You don't need to uncompress or un-tar the distribution files because the install script does that for you. But you will need to make `skedinstall` executable with the command:

```
prompt> chmod +x skedinstall
```

5.3 Installation Instructions

Please follow the steps outlined below to install `sked` and `drudg`. Two script files named `skedinstall` and `skedmake` are provided for installing the programs and source files. The scripts have extensive commenting and information on system requirements. A listing of the install script starts on page SKED-140, the make script is on page SKED-148.

In the installation process, you will first edit the script file to customize `sked` and `drudg` for your system, then run the script to install the files. At this point you will have the standard versions of the `sked` and `drudg` executables and their catalogs and miscellaneous files on your system. If you want to modify any of the compile-time parameters such as array sizes or the absolute path name for the system control file, you may edit the parameter file and then re-make the programs. Finally, you may edit the system control file to set up the default location and names of catalogs, scratch areas, and printer scripts for your system. Follow the descriptions of these steps in the sections below.

Step 1. Space available

Make sure you have about 5 Mbytes of extra space available in the directory in which `skedf.tar.Z` resides for the files that will be extracted from the tar file. Make sure you have available about 35 Mbytes in the area for source files. This is the area to which files in `skeds.tar.Z` will be restored.

Step 2. Edit install script

Now read the install script file `skedinstall` and edit the first part of it to define paths for your system. NOTE: You need to be able to write in the disk areas to which the files are going to be restored. You could run the script as `root`, or as the owner of the disk areas.

In order to decide whether you need to restore source files, you should review the parameter file `skparm.ftni`. A listing of this file starts on page SKED-134. The file has parameters used at

compile time to configure array sizes and constants in `sked` and `drudg`. Parameters in this file include the maximum number of selectable stations and the maximum number of parameters for optimization. If you want to change any parameters for your system, then you will have to restore the source files and re-make the programs. If you do not need to change any parameters, you do not need to restore the source files and you can use the distributed executables. The parameter file will be edited in step 4 below.

The install script only copies and moves files, it does not re-make the programs.

Step 3. Execute install script

Execute the install script redirecting the output as advised in the comments at the head of the script file. The following command will write the standard output and standard error of skedinstall to the file named `skins`.

```
prompt> skedinstall 2>&1 | tee skins
```

The install script will automatically run under the Bourne shell and return to your original shell when it is finished. The script will uncompress the appropriate file(s) and copy or move files to the designated directories. At the completion of the script, you will have the distributed files for catalogs, miscellaneous, and source code installed on your machine. The locations and contents of these files are described starting on page SKED-127. You will also have executable versions of `sked` and `drudg`.

Step 4. Edit parameter file

If you are going to customize the programs for your installation, now you must edit the Fortran parameter file `skparm.ftni` prior to re-making. The file is in the `skedf/skdrincl` subdirectory. Refer to the listing of the distributed version of the file starting on page SKED-134. You can change any of the array dimensions freely, but please take care to make any corresponding changes in other parameters that may be recommended in the comments in the file. Please do not change the values of any of the constants or any of the declarations!

The most likely modification will be to change the location of the system control file. At GSFC the file is `/usr/local/bin/skedf.ctl`, but you may want to put it in a different directory on your system. Please keep the file name the same, for consistency. The system control file is the only file name and path compiled into the program. The locations of all the other files `sked` needs — catalogs, printer scripts, scratch files — are specified in the control file itself (see steps below) and can be changed at any time.

Step 5. Make programs

Now re-make all the libraries and the two programs using the script `skedmake`. Edit the script file to put in the absolute path name of the directory that has the `sked` family source code subdirectories. Refer to the listing of this script starting on page SKED-148. The script makes the libraries in the `lnfch`, `matrix`, and `curses` subdirectories first. Then the library of the utility routines used by both `sked` and `drudg`. Then `sked` is made. Finally `drudg` is made. Each of the libraries and programs can be re-made easily, if necessary, by invoking the makefile in the individual subdirectory.

The makefiles for all programs and libraries are set to use the optimizing options of the Fortran compiler, at a fairly high level. Compilation will require about 10 to 15 minutes. If you modify the makefiles for no optimization, then compilation of all of `sked` requires less than 5 minutes.

Step 6. Edit system control file

Review the control file `skedf.ctl` and edit it to be consistent with the locations of files you have just installed. The control file contains path and directory names for files read and written by `sked` and `drudg`. A listing of the distributed system control file is on page SKED-131, and an example of a personal control file is on page SKED-147.

Step 7. Run sked, drudg

You should now be able to run the customized versions of `sked` and `drudg` installed on your machine.

5.4 Distributed Files

The complete set of distributed files includes all of the files described below. The files are grouped in three categories: catalog files, miscellaneous files, and source code.

5.4.1 Catalog files

The catalog files all have a `.cat` extension and include all of the information needed by `sked` for source, station, and frequency selection. The system control file (see pages SKED-11 and SKED-127) contains the name and location of the files on your system.

Catalog files are not used by `drudg` because all of the required information is extracted from the catalogs and then written into the schedule file.

The file names and contents are listed in the following table.

Catalog File Name	Contents
antenna.cat	antenna name, ID, slewing rates, limits
equip.cat	DAT name and ID, recorder type, SEFDs
flux.cat	source flux densities and gaussian models
flux.cat.comments	source grades and comments on source structure and models
freq.cat	frequency sequences
hdpos.cat	head offsets
loif.cat	station LO frequencies and IF channels
mask.cat	horizon and coordinate masks
modes.cat	observing modes
position.cat	X, Y, Z locations
rec.cat	recording modes
rx.cat	receiver setups by station
source.cat	source names and positions
source.cat.geodetic	geodetic source names and positions
sequence.cat	frequency sequences
tracks.cat	standard Mark III track assignments

Please refer to the **sked's Catalog Files** manual for information on the format and content of these files, and how they reference each other.

5.4.2 Miscellaneous Files

In the miscellaneous category are included the sked and drudg executables and shell scripts for various printer options.

File name	What it is
skedf.ctl	sked, drudg control file
lj	script for laser jet, landscape
ljp	script for laser jet, portrait
lsk	script for laser jet, landscape
lskp	script for laser jet, portrait

5.4.3 Source code files

The sked and drudg source and make files are all contained in subdirectories of a directory of your choice, normally named skedf. There is one subdirectory for the sked program itself, one for

drudg, and others for include files, libraries, and utilities. The contents of each of the subdirectories is briefly described next.

sked/: Contains the source code, makefile, and include files unique to sked. When the program is made, the object files are kept here also.

skdrutil/: Contains the source code for all routines that are used by both sked and drudg. In the makefile, all routines are made into the library file lib/libsked.a. Object files are stored in this subdirectory.

skdrincl/: Contains the .ftni files that are included in both sked's and drudg's source code files. The parameter file for sked and drudg is skparm.ftni. The other files are the COMMON block statements for source, station, and frequency information.

drudg/: Contains source code, makefile, and include files specific to drudg. When drudg is made, the object files are stored here also.

curses/: Contains source code and makefile for the cursor-sensing routines. These are almost identical to those used by solve but there are a few extra features needed by sked.

lnfch/: Contains the LNFCH character manipulation routines needed by sked and drudg. The identical routines are also found in /mk3/src/lnfch and are used by solve. These routines should be compiled with the highest level of optimization.

matrix/: Contains source code and makefiles for matrix manipulation routines. The routines made into the library named dblas.solve are identical to those used by solve. The routines made into the library named dblas.sked are unique to sked. It is important that both of these libraries be compiled with the highest level of optimization.

5.5 Scratch Files

sked names its scratch files uniquely. The last four characters of the file names are the process identification number (pid) of the program. The program utilizes the scratch area designated in your control file. The files listed in the following table are used by sked. Note that the first few letters of the file name are UPPER CASE. *nnnn* is the program's pid.

File	Usage

SKH*nnnnn*	contains the $HEAD section
SKL*nnnnn*	command log file
SKP*nnnnn*	temporary printing file
SKS*nnnnn*	temporary sked file (used when creating a new schedule)
SKT*nnnnn*	another temporary file
SKU*nnnnn*	contains the $FLUX section
SKV*nnnnn*	contains the $VLBA section
SKW*nnnnn*	temporary working file
SKX*nnnnn*	contains the $SOURCES section
SKY*nnnnn*	contains the $STATIONS section
SKZ*nnnnn*	contains the $FREQS section
SKplot	temporary file for plot data

There is no scratch file used for scheduled observations, rather all observations are stored in memory. An index array in memory is used to keep track of the order of the observations, and which ones are deleted. All observations are stored in an array in memory. New observations are always added at the end of the observation array. When the schedule file is written out, observations are accessed in the array using the index array in the correct time order for the $SKED section.

File SKL*nnnnn* contains a log of the commands typed during a sked session. The file is not purged when sked terminates so that it may be examined if necessary after the session. This file may prove helpful in isolating bugs or procedural anomalies. Each time sked starts, a new log file is created. Refer to page SKED-12 for a discussion on how this file can be used to recover if sked aborts.

5.6 File Listings

The following pages contain listings of the distributed versions of files.

skedf.ctl

The listing below is the system control file for `sked`/`drudg`. The comments in this file contain detailed information on the file format and contents. Refer to the discussion on pages SKED-11 about the use of the control file and on page SKED-127 about when to edit this file during installation.

```
*
* skedf.ctl - sked/drudg program control file
*
* This is the default version for sked
*
* This file is free-field except for section names which must begin
* in column 1 with a $. Either upper or lower case is OK for section
* names. Remember that path and file names in Unix are case-sensitive.
*
$catalogs
* This section is not used by drudg.
*catalog   file name
source     /usr/local/catalogs/source.cat.geodetic
hdpos      /usr/local/catalogs/hdpos.cat
flux       /usr/local/catalogs/flux.cat
comments   /usr/local/catalogs/flux.cat.comments
antenna    /usr/local/catalogs/antenna.cat
position   /usr/local/catalogs/position.cat
equip      /usr/local/catalogs/equip.cat
mask       /usr/local/catalogs/mask.cat
freq       /usr/local/catalogs/freq.cat
rx         /usr/local/catalogs/rx.cat
loif       /usr/local/catalogs/loif.cat
modes      /usr/local/catalogs/modes.cat
tracks     /usr/local/catalogs/tracks.cat
rec        /usr/local/catalogs/rec.cat
*
*
$schedules
* Enter the path name for schedule (.skd) files. If not specified,
* the default is null, i.e. use the local directory.
*
$snap
* Enter the path name for SNAP (.snp) files made by drudg. If not
* specified, the default is null, i.e. use the local directory.
*
$proc
* Enter the path name for procedure (.prc) files made by drudg. If
* not specified, the default is null, i.e. use the local directory.

$scratch
* Enter the path name for temporary files. If not specified, the default
```

```
* is null, i.e. use the local directory.
/tmp/
*
$print
* Printer type:
* Enter the printer type for drudg. If not specified, default is laser.
* Recognized names: laser, epson, epson24.
* This can be changed interactively with option 9.
* Examples:
* printer laser
* printer epson
* printer epson24
*
* Printer type:
* Enter any command strings or scripts to be used for printing in
* portrait or landscape. The key words "landscape" and "portrait"
* indicate the orientation.  Following the key word, all characters
* on the line (including blanks) are read as the command.
* If no commands or scripts are specified, drudg defaults to embedding
* escape sequences for the output desired into the file and uses
* the system command "recode latin1:ibmpc" piped to "lpr" to print
* the temporary file.
* Examples:
* This example is for a laser printer, 6 lines/inch, 10 char/inch:
*portrait lpr -ofp10 -olpi6 $*
* This example is the same as above but for landscape:
*landscape lpr -ofp10 -o1pi6 -olandscape $*
* These examples are the same as above but for a smaller font:
*portrait lpr -ofp16.66 -olpi6 $*
*landscape lpr -ofp16.66 -o1pi6 -olandscape $*
*portrait <script name for portrait output>
*landscape <script name for landscape output>
landscape    lsk
portrait     lskp
*
* Output control:
* Enter the desired orientation and font size for listings. Key words
* are option1, option4, and option5 for the three listing options.
* Follow the key word by a 2-letter code, first letter "p" or "l" for
* portrait or landscape, second letter "s" or "l" for small or large
* font. If none are specified, the defaults are as listed below:
*option1 ls (landscape, small font)
*option4 ps (portrait, small font)
*option5 ps (portrait, small font)
*
* Tape label script:
* Enter a script for printing tape labels. If no script is specified,
* the default is to use "lpr" to print the temporary file.
* Examples:
*labels <script name for label printing>
*
* Tape label printer:
* Enter the name of the label printer for drudg. If no name is specified,
drudg * will not attempt to print tape labels. Recognized names are
postscript, * epson, epson24, laser+barcode_cartridge.
```

```
* Examples:
*label_printer postscript
*label_printer laser+barcode_cartridge
*label_printer epson
*label_printer epson24
*
* Label size:
* Specify label size parameters, only valid for "postscript" type. If
* no size is specified, drudg cannot print labels.
* <ht> height of a single label, in inches
* <wid> width of a single label, in inches
* <rows> number of rows of labels on the page
* <cols> number of columns of labels on the page
* <top> offset of the top edge of the first row of labels from the
*      top of the page, in inches
* <left> the offset of the left edge of the first column of labels
*      from the left side of the page, in inches
* Format:
* label_size <ht> <wid> <rows> <cols> <top> <left>
* Examples:
*label_size  1.0   2.625  10     3     0.5   0.3125 Avery 5160
*label_size  1.333 4.0     7     2     0.5   0.25   Avery 5162
*label_size  2.0   4.0     5     2     0.5   0.25   Avery 5163
*label_size  1.5   4.0     6     2     0.75  0.25   Avery 5197
*label_size  1.375 2.75    8     3     0.0   0.0    HP 92285L
*label_size  1.5   3.9     7     2     0.5   0.16   Avery L7163
*
*$misc
* Enter the epoch for drudg to use on the SOURCE commands in SNAP files.
* Default is 1950 if none is specified. Only 1950 or 2000 are valid.
* Examples:
*epoch 2000
*epoch 1950
```

skparm.ftni

The listing below is the distributed version of the `sked`/`drudg` parameter file. This file is included in most of the source code files for `sked` and `drudg`. Array sizes, default path names and file names, and certain constants are the primary contents of this file. Refer to page SKED-125, 126 for a discussion about the need to modify this file before you re-make the programs.

```
C*********************************************************************
C
C     SKPARM.FTNI HOLDS PARAMETERS FOR THE SKED FAMILY OF PROGRAMS.
C     Parameters which are used by SKED and/or DRUDG are
C     collected here.
C
C  Last modified:  890623 by NRV to add windows parameters
C 891113 NRV Add max base/flux parameter
C 900125 NRV added max tape length parameter
C 900206 NRV Modified to remove SOCAT, STCAT
C 900302 gag removed catalogs, luscn and luusr
C 911026 NRV Changed flux parameters
C 911215 NRV Changed max_chart to 100 (per Heinz)
C 920528 NRV Add MAX_SEFDPAR
C 920702 NRV Changed MAX_HOR,COR to 30
C 930204 NRV Merged sked parameters into this version
C 930308 NRV Changed autosked max parameters to use previously
C            defined parameters for source and station numbers
C 930408 nrv Add oblank (single blank character)
C            Add octal constants
C 930506 nrv Changed max_stn to 14
C 931015 nrv Add flcon1, flcon2 (removed from obsfl)
C 931223 nrv Change to 4000 scans (for test schedules)
C 940112 nrv Make the default be 100 celestial, 5 satellites
C            Change to 2000 scans as default.
C 940719 nrv Special version for 35 stations
C 940805 nrv Back to normal values
C            Add MAX_NRS parameter
C 950622 nrv Change MAX_PASS to 28 for 4-pass mode C with VLBA
C 951018 nrv Add obar
c 951019 nrv Add MAX_CHAN to replace hard-coded "14"'s
C 960226 nrv Increase MAX_HOR to 40
C 960412 nrv Test 300 sources
C 960516 nrv Add MAX_FLD, set to 20
C 960522 nrv Add lots of max's, change max_pass to index*subpasses
C 960628 nrv Allow more modes in catalog.
C 970114 nrv Add MAX_SORLEN, length of source names.
C 970204 nrv Change max_subpass to 8
C 970206 nrv Chage max_headstack to 1
C
C*********************************************************************
```

```
C
      implicit none
C
C     The maximum number of stations which can be selected for
C     an experiment at one time.  Used in SKED and DRUDG.
C
      integer max_stn,max_baseline,max_hor,max_cor,max_headstack,
     .max_track,max_pass,max_ifd,max_bbc,max_index,max_chan,
     .max_subpass

C     PARAMETER (MAX_STN = 16)
      PARAMETER (MAX_STN = 35)
C
C     The maximum number of baselines.
C
      PARAMETER (MAX_BASELINE = (MAX_STN*(MAX_STN-1))/2)
C
C     The maximum number of az/el and coordinate pairs for horizon
C     and coordinate masks. 18 is the maximum number allowed without
C     increasing the buffer size.
C
      PARAMETER (MAX_HOR = 60)
      PARAMETER (MAX_COR = 30)
C
C     The maximum number of sources, celetial AND satellite
C     which can be selected for an experiment at one time.
C     This must be the largest parameter of the maximum
C     parameters used with the stations, frequencies and sources.
C     Used in SKED and DRUDG.
C *** NOTE: If this value is changed, then at least one of MAX_CEL
C *** and MAX_SAT must be changed, so that MAX_SOR = MAX_CEL + MAX_SAT.
C
      integer max_sor,max_cel,max_sat,max_frq
      PARAMETER (MAX_SOR = 305)

C     The maximum number of CHARACTERS in a source name. Should be
C     an even integer. Maximum size now is 26, to be cmpatible with
C     the multiple-use arrays in skcom. Increase the LNASEx arrays if
C     you need longer source names.
      integer max_sorlen
      PARAMETER (MAX_SORLEN = 16)
C
C     The maximum number of celestial (RA,DEC) sources which can
C     be selected for an experiment at one time. Used in SKED,SOCAT,DRUDG.
C *** NOTE: If this value is changed at least one of MAX_SOR
C *** and MAX_SAT must be changed, so that MAX_SOR = MAX_CEL + MAX_SAT.
C
      PARAMETER (MAX_CEL = 300)
C
C     The maximum number of satellite (orbital element) sources which
C     can be selected for an experiment at one time. Used in SKED
C     and DRUDG.
C *** NOTE: If this value is changed, then at least one of MAX_SOR
C *** and MAX_CEL must be changed, so that MAX_SOR = MAX_CEL + MAX_SAT.
C
```

```
      PARAMETER (MAX_SAT = 5)
C
C     The maximum number of frequency codes which can be selected
C     for use in an experiment at one time.  Used in SKED and DRUDG.
C
      PARAMETER (MAX_FRQ = 20)
C
C     The maximum number of frequency bands within a schedule.
C       **NOTE** This is restricted to be no more than 2!
C       There are places in SKED that may appear to handle more
C       than two bands, but this feature is really tailored to
C       only S/X observations. ***
C     Several frequency codes may be selected, as long as they
C     are composed of a maximum of two bands, e.g. S and X.
C
      integer max_band,max_flux,max_vlba,max_sefdpar,max_nrs
      PARAMETER (MAX_BAND = 2)
C
C     The maximum size of flux arrays. For source models, this number
C     is the maximum number of model components times 6, because
C     there are 6 parameters for a gaussian model. The value of 18
C     allows for 3 components, although no source models currently have
C     more than 2 components. For baseline/flux profiles, this is the
C     maximum number of entries in the profile. The value of 18 allows
C     for 9 baselines and 8 fluxes, more than generous to describe a
C     source.
C
      PARAMETER (MAX_FLUX = 18)
C
C     Maximum number of VLBA entries.

      parameter (max_vlba = MAX_STN*MAX_FRQ)
C
C     Maximum number of rise/set times in arrays.

      parameter (MAX_NRS = 4)
C
C     Maximum number of parameters for the calculation of
C     elevation-dependent SEFDs.

      parameter (MAX_SEFDPAR = 5)
C
C     Maximum number of headstacks. Limited to 2 within sked/drudg
C     for now. Change to 1 to save space.

      parameter (max_headstack = 1)

C     Maximum number of tracks on a headstack.

      parameter (max_track = 36)

C     Maximum number of index positions for the headstacks.

      parameter (max_index = 14)
```

```
C     Maximum number of subpasses per index position. Set to
C     4 for now, to save array space. Increase to 8.

      parameter (max_subpass = 36)
C
C     Maximum number of passes that are possible.

      parameter (max_pass = max_index*max_subpass)

C     Maximum number of IFs in a system.

      parameter (max_ifd = 4)

C     Maximum number of BBCs in a system.

      parameter (max_bbc = 16)

C     Maximum number of video channels.
C
      PARAMETER (MAX_CHAN = 16)

C     Value for PI.
C
      real*8 PI,ROG,ROZ,SECRAD,OMEGA,EPS,ROS,C,TWOPI
      PARAMETER (PI = 3.1415926535897932D0)
      PARAMETER (TWOPI = 2.d0*PI)
C
C     EPSILON FOR 23 DEG AND 27 MIN IN RADIANS
      PARAMETER (EPS=0.4092797096D0)
C
C     Speed of light
      PARAMETER (C=2.99792458D8)
C
C     Degrees per radian
      PARAMETER (ROG=57.2957795131D0)
C
C     Seconds of time per radian
      PARAMETER (ROZ=13750.98708313D0)
C
C     Seconds of arc per radian
      PARAMETER (ROS=206264.8062471D0)
C
C     Radians per second of arc
      PARAMETER (SECRAD=4.8481368111D-6)
C
C     Radians per second of time
      PARAMETER (OMEGA=7.272205217D-5)
C
      real*8 flcon1,flcon2
C     Note: 0.6931471=alog(2)
      PARAMETER (flcon1 = (pi*pi)/(4.0*0.6931471))
      PARAMETER (flcon2 = pi/(3600.d0*180.d0*1.d3)) ! marcsec --> radians

      integer max_par_esti,max_par_opti,max_dim_esti
      integer max_sor_esti,max_chart
```

```
C     Maximum number of parameters that can be estimated.
      PARAMETER (MAX_PAR_ESTI=50)
C     PARAMETER (MAX_PAR_ESTI=20)
C
C     Maximum number of parameters that can be optimized
      PARAMETER (MAX_PAR_OPTI=30)
C     PARAMETER (MAX_PAR_OPTI=10)
C
C     Maximum dimension for arrays holding coefficients etc.
C     This parameter is = 269 for 100 sources, 8 stations
C                         277 for 100 sources, 9 stations
C                         285 for 100 sources, 10 stations

      PARAMETER (MAX_DIM_ESTI=5+2*MAX_SOR+8*MAX_STN)
C
C     Maximum number of sources for which positions can be estimated
      PARAMETER(MAX_SOR_ESTI=10)
C     PARAMETER(MAX_SOR_ESTI=1)
C
C     Maximum number of subconfigurations that will be
C     examined for possible scheduling.

      PARAMETER(MAX_CHART=100)
C
      integer max_tape
C
C     Default maximum tape length.  This value is usually
C     specified for each station in the equipment catalog.
C
      PARAMETER (MAX_TAPE = 8820)
C
C
      INTEGER  NULL
      PARAMETER (NULL = 0)

C     Definitions for octal constants.

      integer OBLANK,ODOLLAR,OZERO,OCOMMA,OMINUS,OPLUS,
     .          ODOT,OLPAREN,OUNDERSCORE,OSTAR,OSLASH,OAND,
     .          ORPAREN,OBAR
      parameter (OBLANK = O'40', ODOLLAR = O'44',
     .OZERO = O'60', OCOMMA = O'54', OMINUS = O'55',
     .OPLUS = O'53', ODOT = O'56', OLPAREN = O'50',
     .ORPAREN = O'51',OUNDERSCORE = O'137', OSTAR = O'52',
     .OSLASH = O'57', OAND = O'46', OBAR = O'140')
      integer OCAPA,OCAPB,OCAPC,OCAPD,OCAPE,OCAPF,OCAPX,
     .OCAPY,OCAPW,OSMALLE,OCAPL,OCAPT,OCAPN,ONINE,OCAPH,
     .OCAPP,OONE,OCAPZ,OSMALLA,OSMALLZ,OCAPU,OCAPV,OCAPR,
     .ocapi,ocapo
      parameter (OCAPA = O'101', OCAPB = O'102',
     .OCAPC = O'103', OCAPD = O'104', OCAPE = O'105',
     .OCAPF = O'106', OCAPX = O'130', OCAPY = O'131',
     .OCAPW = O'127', OCAPL = O'114', OCAPN = O'116',
     .OSMALLE = O'145', OCAPT = O'124', ONINE = O'71',
     .OCAPH = O'110', ocapi = o'111', ocapo = o'117',
```

```
     .OCAPP = O'120', OCAPZ = O'132',
     .OONE = O'61', OSMALLZ = O'172', OSMALLA = O'141',
     .OCAPU = O'125', OCAPV = O'126', OCAPR = O'122')

C     Unit 5 = standard input (keyboard)
C     Unit 6 = standard output (screen)

      INTEGER STDIN,STDOUT,STDERR
      PARAMETER (STDIN = 5, STDOUT = 6, STDERR = 7)
C
C
C     The lengths of the general purpose buffers IBUF and IBUFQ
C     are determined by MAX_STN as follows:
C     length of IBUF in chars must be >=60+MAX_STN*13
C     IBUFQ is 1 word longer than IBUF.
C     ***NOTE*** You must modify the read/write statements in
C     readf_asc and writf_asc to extend the buffer size als.
C
      integer ibuf_len,ibufq_len,max_obs,max_ent_sor,ibfcom_len
      PARAMETER (IBUF_LEN = 499)
      PARAMETER (IBUFQ_LEN = 500)
C     PARAMETER (IBUF_LEN = 256)
C     PARAMETER (IBUFQ_LEN = 257)
C
C     The maximum number of scans allowed in a schedule
C
      PARAMETER (MAX_OBS = 2000)
C
C     The maximum number of entries in the source
C     catalog. CAUTION: YOU MUST ALSO CHANGE IBFCOM_LEN BELOW.
C
      PARAMETER (MAX_ENT_SOR = 1000)
C
C     The length of array IBFCOM = 4*MAX_ENT_SOR
C
      PARAMETER (IBFCOM_LEN = 4000)
C
C     The maximum number of entries in the station
C     catalog. This must be no more than 108. This
C     is because the station and frequency selection
C     options only can display one page on the terminal.
C     (Limit set by NROWS*NCOLS in SEST)
C
      integer max_ent_stn
      PARAMETER (MAX_ENT_STN = 100)
C
C     The maximum number of entries in the modes catalog that
C     will be read for selection.

      integer max_ent_modes
      PARAMETER (MAX_ENT_MODES = 50)

C     The maximum size of the selection array, for all types of
C     selection. This must be the larger of MAX_ENT_SOR, and
C     MAX_FRQ*MAX_STN.
```

```
      integer max_sel
      PARAMETER (MAX_SEL = MAX_ENT_SOR)

C     The name of the control files. These files are
C     read at run time. cctfil is the default control
C     file that SKED reads each time it is run and should
C     be in the users path. cownctl is a
C     personal control file that should be in the
C     directory of the user when running SKED if it is
C     to be used.
C
      character*128 cctfil,cownctl
C this path is for Goddard's HPUX
      parameter(cctfil = '/usr/local/bin/skedf.ctl')
C this path is for Linux FS
C     parameter(cctfil = '/usr2/control/skedf.ctl')
      parameter(cownctl = 'skedf.ctl')

C
```

skedinstall

The listing below is the complete install script for `sked`/`drudg`. Refer to the installation instructions, starting on page SKED-125, for how to use this file. In this listing, some of the very long lines wrap around but these are single lines in the file.

```
#!/bin/sh
#############################################################################
#
#  ---------------
#  | skedinstall |     3-30-90  fgg  (original version)
#  |             |     910716   nrv  (removed gjet)
#  ---------------     930329   nrv  (simplified for 7xx installation
#                                     only and tar file only)
#                      930413   nrv  (add drudg)
#                      960410   nrv  (remove make)
#                      970411   nrv  (add VEX)
#
#
#  NOTE:
#  It is recommended that you be the super-user when this
#  running this script. Otherwise, you need to have write
#  permission to all the directories where the files are to be
#  restored.
#
#  PURPOSE:
#  This shell script should be used to install SKED and DRUDG on
#  your HP-UX system (HP9000/ 7xx machines only). This script will
#  run under the Bourne shell and return to the original shell
#  upon completion. After the files have been installed properly,
#  use the script "skedmake" to make the libraries and executables.
#
#  For this script to work properly, certain parameters such as where
#  SKED and DRUDG will be installed, the machine you are currently
#  installing on, etc., must be inserted into this script, i.e., this
#  script will have to be edited by YOU, (presumably the system manager)
#  to customize it for your particular system.  There will be comments
#  in this script that will tell you how to do this.  Once you have
#  finished editing this script, simply run it.  It will send messages
#  to your screen, informing you about what is going on, what is being
#  installed where, when things are completed, etc.  You should TEE the
#  standard output and standard error of this script to a file when you
#  run it so that you you can get a hard copy of the installation session
#  for your future reference. Method:
#           if running /bin/sh:    skedinstall 2>&1 | tee <filename>
#           if running /bin/csh:   skedinstall |& tee <filename>
```

```
#  will put the standard output and standard error of skedinstall to
#  <filename>.
#
#  GENERAL NOTE:
#  As you know, if the destination directories you specify are not
#  empty, any files that exist with the same name as the ones that
#  will be installed will be overwritten.  You should move any old
#  versions of SKED and the miscellaneous files from their directory
#  if you want to use their directory for the current install.
#
#########################################################################

#########################################################################
#
#       Please specify the absolute pathname of
#       "skedf.tar.Z"'s directory in the following line:

compTARdir=""

#       (NOTE:  The compressed TAR file "skedf.tar.Z" doesn't contain
#               source for SKED).

#       Please specify the absolute pathname of the directory
#       of the compressed TAR file containing the source code
#       ("skeds.tar.Z") in the following line:

srcTARdir=""

#       (NOTE:  The compressed TAR file "skeds.tar.Z" contains ONLY
#               source for SKED).

#########################################################################

#########################################################################
#
#  Destination Directory for SKED and DRUDG source files, objects, makefiles:
#
#       NOTE:
#       You don't need to restore the source files if you don't need to
#       change any of the parameters in the file "skparm.ftni".  Refer
#       to the listing of that file in the SKED documentation and to
#       the update notice.

#       If you do choose to restore the source files to your system, then
#       the following sub-directories will be created in a directory of
#       your choice.  Your chosen directory should not have any sub-
#       directories with the same names as these:
#
#       curses/, drudg/, matrix/, skdrincl/, lnfch/, sked/, skdrut/, vex/
#

#  If you want the source code for SKED and DRUDG (for possible re-MAKEs),
#  specify the destination directory on your current system.  Give the
#  ABSOLUTE pathname, please (e.g., /data31/skedf  is where these seven
#  directories are located on the HPs at GSFC, so the line would read:
```

```
#  sourcedest=/data31/skedf.  If you don't want the source loaded, then
#  leave this line alone.

sourcedest=""

########################################################################

########################################################################
#
#  Destination Directory for SKED and DRUDG executables, and miscellaneous
#  files:
#
#       The recommended destination directory for all these files is
#       /usr/local/bin.  This is a standard place to put user-written
#       executables that are not associated with the HP-UX operating system.
#       You may put the SKED executable in one directory, catalogs
#       in another, and the miscellaneous files in yet another, but
#       having them all dispersed like this is confusing and unnecessary.
#
#       The SKED and DRUDG executables are named "sked" and "drudg".
#       The executable must be installed; any future re-MAKES will over-write
#       them.
#
#       The destination directories for SKED and DRUDG should be in the
#       $PATH of every potential SKED user (this must be done extern-
#       ally from this script if necessary).
#
#       These are the miscellaneous files on the distribution medium:
#
#       lj, ljp, lsk, lskp, and skedf.ctl
#       (see SKED documentation for descriptions of these files)
#
#       The miscellaneous files should be placed in a directory that is
#       in every potential user's $PATH (must be done externally from
#       this script if necessary).

#       Replace the default in the following line with the absolute pathname
#       of your destination directory for "sked":

skexedest=""

#       Replace the default in the following line with the absolute pathname
#       of your destination directory for miscellaneous files:

miscdest=""

#       Replace the default in the following line with the absolute pathname
#       of your destination directory for "skedf.ctl":

skctldest=""

########################################################################

########################################################################
#
```

```
#  Destination Directory for catalogs:
#
#       The recommended directory for the catalogs is "/usr/local/catalogs".
#       Replace the default in the following line with the absolute pathname
#       of the destination directory for catalog files:

catadest=""

#########################################################################

#########################################################################
#
#  Name of Temporary Directory:
#
#       There should be a directory on your HP-UX system where scratch
#       files are created by the operating system or user processes.  Since
#       SKED will use that area extensively, you must specify
#       the name of the scratch area on your system.  This scratch area
#       comes standard on every HP-UX system and is probably right under
#       the root directory with a name such as "/tmp" or "/temp".  This
#       installation script will also use that area.  Make sure that there
#       is at least 9 or 10 meg of free space available in it before you
#       run this script.
#
#       Find out what it is for your current system and replace the "" in
#       the following line with the absolute pathname of this scratch direc-
#       tory.

tempdir=""

#########################################################################

#########################################################################
#
#  INSTALLATION
#
bold=`tput smso`
nobold=`tput rmso`
tput clear
echo "${bold}*************** SKED Installation ***************${nobold}"
echo "\n\n"
echo "\nHit return to begin installation...\c"
read goinstall
echo "\nThe installation will proceed with these values that you have"
echo "specified in the install file \"$0\":"
if [ ! -z "$compTARdir" ]
then
   echo "Compressed TAR file (skedf.tar.Z) location:   $compTARdir"
fi
if [ ! -z "$srcTARdir" ]
then
   echo "Compressed TAR file (skeds.tar.Z) location:   $srcTARdir"
fi
if [ ! -z "$sourcedest" ]
then
```

```
   echo "Source Destination:   $sourcedest"
fi
echo "SKED Executable Dest. :   $skexedest"
echo "Miscell. Files Dest.  :   $miscdest"
echo "Skedf.ctl File Dest.  :   $skctldest"
echo "Catalog Destination   :   $catadest"
echo "System Temp. Directory:   $tempdir"
echo "\nIf any of the above specified paths are not written as absolute"
echo "pathnames, then this is an error"
echo "and the install file \"$0\" must be re-edited to correct this."
echo "If any of the paths are not what you want them to be, you may quit"
echo "this install at this point.  Otherwise, installation will proceed"
echo "with the values shown above."
baddir=false

if [ -z "$compTARdir" ]
then
      if [ -z "$srcTARdir" ]
      then
         echo "\nERROR:  If you are getting the source for SKED"
         echo "by compressed TAR file (skeds.tar.Z), then you also need"
         echo "the other compressed TAR file (skedf.tar.Z) which contains"
         echo "miscellaneous files, utilities, and catalogs.  The location"
         echo "of skedf.tar.Z was not given in the install file.  Please"
         echo "edit the install file \"$0\" correctly and try again."
         baddir=true
      fi
else
   if [ ! -d "$compTARdir" ]
   then
      echo "\nERROR: Non-existent directory specified for location of"
      echo "compressed TAR file \"skedf.tar.Z\".  Please edit the install"
      echo "file \"$0\" correctly and try again."
      baddir=true
   else
      if [ ! -f "$compTARdir/skedf.tar.Z" ]
      then
         echo "\nERROR: Compressed TAR file "skedf.tar.Z" does not exist"
         echo "in the specified directory \"$compTARdir\".  Please edit the"
         echo "install file \"$0\" correctly and try again."
         baddir=true
      fi
   fi
   if [ ! -z "$srcTARdir" ]
   then
      if [ ! -d "$srcTARdir" ]
      then
      echo "\nERROR: Non-existent directory specified for location of"
      echo "compressed TAR file \"skeds.tar.Z\".  Please edit the install"
      echo "file \"$0\" correctly and try again."
      baddir=true
      fi
      if [ ! -f "$srcTARdir/skeds.tar.Z" ]
      then
         echo "\nERROR: Compressed TAR file "skeds.tar.Z" does not exist"
```

```
         echo "in the specified directory \"$srcTARdir\".  Please edit the"
         echo "install file \"$0\" correctly and try again."
         baddir=true
      fi
   fi
fi

if [ \( ! -z "$sourcedest" \) -a \( ! -d "$sourcedest" \) ]
then
   echo "\nERROR: The directory \""$sourcedest"\" doesn't exist on your system."
   echo "You must create this directory externally if you want to use it."
   baddir=true
fi
if [ -z "$skexedest" ]
then
   echo "\nERROR: You must specify a directory for the SKED and DRUDG executables."
   baddir=true
else
   if [ ! -d $skexedest ]
   then
      echo "\nERROR: The directory \""$skexedest"\" doesn't exist on your system."
      echo "You must create this directory externally if you want to use it."
      baddir=true
   fi
fi
if [ -z "$miscdest" ]
then
   echo "\nERROR: You must specify a directory for the miscellaneous files."
   baddir=true
else
   if [ ! -d $miscdest ]
   then
      echo "\nERROR: The directory \""$miscdest"\" doesn't exist on your system."
      echo "You must create this directory externally if you want to use it."
      baddir=true
   fi
fi
if [ -z "$skctldest" ]
then
   echo "\nERROR: You must specify a directory for the skedf.ctl file."
   baddir=true
else
   if [ ! -d $skctldest ]
   then
      echo "\nERROR: The directory \""$skctldest"\" doesn't exist on your system."
      echo "You must create this directory externally if you want to use it."
      baddir=true
   fi
fi
if [ -z "$catadest" ]
then
   echo "\nERROR: You must specify a directory for the catalogs."
   baddir=true
else
   if [ ! -d $catadest ]
```

```
   then
      echo "\nERROR: The directory \""$catadest"\" doesn't exist on your system."
      echo "You must create this directory externally if you want to use it."
      baddir=true
   fi
fi
if [ -z "$tempdir" ]
then
   echo "\nERROR: You must specify the system temporary directory ."
   baddir=true
else
   if [ ! -d $tempdir ]
   then
      echo "\nERROR: The directory \""$tempdir"\" doesn't exist on your system."
      echo "You must create this directory externally if you want to use it."
      baddir=true
   fi
fi
if [ $baddir = true ]
then
   echo "\nPlease fix errors, exiting..."
   exit
fi

echo "\nDo you wish to continue (y=yes, n=no) ? : \c"
badans=true
while [ $badans = true ]
do
   read ans
   case "$ans" in
      y|yes)  echo "\nO.K. Continuing with install..."
              badans=false
              ;;
      n|no)   echo "\nO.K. Exiting..."
              exit
              ;;
      *)      echo "\nPlease answer (y=yes, n=no) : \c"
   esac
done


if [ -z "$sourcedest" ]
then
   echo "\nInstaller did not want to load source files."
   echo "continuing..."
else
   echo "\nInstalling source files under directory $sourcedest."
   echo "Please wait..."
   cd $sourcedest
   echo `pwd`
   if [ ! -z "$srcTARdir" ]
   then
      mv $srcTARdir/skeds.tar.Z .
      echo "Uncompressing \"skeds.tar.Z\"..."
      /usr/bin/uncompress skeds.tar.Z
```

```
      echo "Extracting files from \"skeds.tar\"..."
      tar xf skeds.tar
      /usr/bin/compress skeds.tar  # restore to previous state
      mv skeds.tar.Z $srcTARdir
   fi
   echo "\nInstallation of source files completed."
   echo "continuing..."
fi

echo "\nPlease wait..."
if [ ! -z "$compTARdir" ]
then
   cd $compTARdir
   echo "Uncompressing \"skedf.tar.Z\"..."
   /usr/bin/uncompress skedf.tar.Z
   echo "Extracting files from \"skedf.tar\"..."
   tar xf skedf.tar
   /usr/bin/compress skedf.tar    # restore to previous state
else
   cd $tempdir
   echo `pwd`
fi

echo "\nInstalling SKED executable under directory $skexedest."
echo "Please wait..."
mv skedexe $skexedest/sked
chmod +x $skexedest/sked
echo "\nInstallation of SKED executable completed."
echo "continuing..."

echo "\nInstalling DRUDG executable under directory $skexedest."
echo "Please wait..."
mv drudgexe $skexedest/drudg
chmod +x $skexedest/drudg
echo "\nInstallation of DRUDG executable completed."
echo "continuing..."

echo "\nInstalling miscellaneous files under directory $miscdest."
echo "Please wait..."
chmod +x lj ljp lsk lskp
mv lj ljp lsk lskp $miscdest
echo "\nInstallation of miscellaneous files completed."
echo "continuing..."

echo "\nInstalling catalogs under directory $catadest."
echo "Please wait..."
mv `ls *.cat` updates source.cat.geodetic flux.cat.comments $catadest
echo "\nInstallation of catalogs completed."
echo "continuing..."

echo "\nInstalling \"skedf.ctl\" under directory $skctldest."
echo "Please wait..."
mv skedf.ctl $skctldest
echo "\nInstallation of \"skedf.ctl\" completed."
echo "continuing..."
```

```
echo "\n\nSKED Installation complete !"
exit
```

skedf.ctl (personal)

The listing below is a sample personal control file for `sked`/`drudg`. Please refer to the discussion starting on page SKED-? which describes typical uses for a personal control file.

```
*
* SKEDF.CTL - NRV's personal control file
*
$catalogs
*
*
$schedules
*
/users/nrv/schedules/
*
$drudg
*
$scratch
*
$print
*
landscape    lsk
portrait     lskp
```

skedmake

The script listed below makes all of the `sked` and `drudg` libraries and utility routines as well as the two main programs. Refer to the discussion on page SKED-126 about the use of this file.

```
#!/bin/sh
#########################################################################
#                                                                       #
#          Script to make SKED and its libraries                        #
#                 and DRUDG                                             #
#                  NRV  930413                                          #
# 960513 nrv Remove "lib" subdirectory                                  #
# 970411 nrv Add making VEX library                                     #
#########################################################################

# Edit the following line to put between the quotes the absolute path
# name of the directory that has all of the sked subdirectories in it.
# No other editing of this file is necessary.

sourcefiles="/users/nrv/askedd"

# Make the lnfch Hollerith routines
cd $sourcefiles/lnfch
echo "$sourcefiles/lnfch"
/bin/rm *.o
/bin/rm lnfch.a
make

# Make the curses library routines
cd $sourcefiles/curses
echo "$sourcefiles/curses"
/bin/rm *.o
/bin/rm curses.a
make

# Make the two matrix manipulation libraries.
# NOTE: the library named dblas.solve is identical to the library
#       named dblas.a used by solve. The library dblas.sked contains
#       the routines not found in dblas.
cd $sourcefiles/matrix
echo "$sourcefiles/matrix"
/bin/rm *.o
rm dblas.sked
make -f Makefile.sked
rm dblas.solve
make -f Makefile.solve

# Make the sked/drudg utilities library.
```

```
cd $sourcefiles/skdrut
echo "$sourcefiles/skdrut"
/bin/rm *.o
/bin/rm skdrut.a
make

# Make the VEX utilities library
cd $sourcefiles/vex
echo "$sourcefiles/vex"
/bin/rm/*.o
/bin/rm/vex.a
make

# Now make sked. All libraries are now available. Remove
# the object files to make sure they are all gone.
cd $sourcefiles/sked
echo "$sourcefiles/sked"
/bin/rm *.o
make -f Makefile.opt

# Make drudg. sked libraries are used in this make.
cd $sourcefiles/drudg
echo "$sourcefiles/drudg"
/bin/rm *.o
make

echo "Don't forget to copy the executable sked and drudg files"
echo "     to your directory for binary files."
```